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ORIGINAL REPORT

End-of-Life Racial and Ethnic Disparities Among Patients With Ovarian Cancer

Jolyn S. Taylor, Suja S. Rajan, Ning Zhang, Larissa A. Meyer, Lois M. Ramondetta, Diane C. Bodurka, David R. Lairson, and Sharon H. Giordano

Author affiliations and support information (if applicable) appear at the end of this article.

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Corresponding author: Jolyn S. Taylor, MD, MPH, Cancer Prevention Building, Suite CPB6.3584, 1155 Pressler St, Unit 1362, Houston, TX 77030; e-mail: jstaylor1@mdanderson.org.

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ABSTRACT

Purpose
To assess disparities in end-of-life care among patients with ovarian cancer.

Patients and Methods
Using Texas Cancer Registry-Medicare data, we assessed patients with ovarian cancer deceased in 2000 to 2012 with at least 13 months of continuous Medicare coverage before death. Descriptive statistics and multivariate logistic regressions were conducted to evaluate end-of-life care, including chemotherapy in the final 14 days of life, intensive care unit (ICU) admission in the final 30 days of life, more than one emergency room (ER) or hospital admission in the final 30 days of life, invasive or life-extending procedures in the final 30 days of life, enrollment in hospice, enrollment in hospice during the final 3 days of life, and enrollment in hospice while not hospitalized.

Results
A total of 3,666 patients were assessed: 2,819 (77%) were white, 553 (15%) Hispanic, 256 (7%) black, and 38 (1%) other. A total of 2,642 (72%) enrolled in hospice before death, but only 2,344 (64%) died while enrolled. The median hospice enrollment duration was 20 days. In the final 30 days of life, 381 (10%) had more than one ER visit, 505 (14%) more than one hospital admission, 593 (16%) ICU admission, 848 (23%) invasive care, and 418 (11%) life-extending care. In the final 14 days of life, 357 (10%) received chemotherapy. Several outcomes differed for minorities compared with white patients. Hispanic and black patients were less likely to enroll and die in hospice (black odds ratio [OR], 0.66; 95% CI, 0.50 to 0.88; $P = .004$; Hispanic OR, 0.76; 95% CI, 0.61 to 0.94; $P = .01$). Hispanic patients were more likely to be admitted to an ICU (OR, 1.37; 95% CI, 1.05 to 1.78; $P = .02$), and black patients were more likely to have more than one ER visit (OR, 2.20; 95% CI, 1.53 to 3.16; $P < .001$) and receive a life-extending procedure (OR, 2.13; 95% CI, 1.49 to 3.04; $P < .001$).

Conclusion
We found being a minority was associated with receiving intensive and invasive end-of-life care among patients with ovarian cancer.

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INTRODUCTION

There is increasing recognition of the importance of optimizing the use of medical care during the end of life. The ASCO Quality Oncology Practice Initiative, the Physician Consortium for Performance Improvement, and the National Quality Forum have quality-of-care guidelines recommending against intensive and invasive medical care at the end of life.[1-3] Avoidance of such aggressive care may lead to improved quality of life and lower health care costs.[4-8] These quality-of-care measures include minimizing the receipt of chemotherapy and the number of hospital, intensive care unit (ICU), and emergency center (ER) admissions during the final days of life and completing advanced directives and referrals to palliative care and hospice in a timely manner before death. Additional quality of end-of-life care metrics includes early enrollment in hospice as an outpatient (as opposed to enrolling during a hospital admission).[1,3,8-10]

Ovarian cancer is the leading cause of death among gynecologic cancers and is the fifth most common cause of death from cancer among women.[11] Although changes have occurred over the last decade leading to increased hospice use by patients with ovarian cancer before death, many patients still receive intensive and invasive care in the last month of life.[12,13] Similar to other disease

ASSOCIATED CONTENT

Appendix
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sites, patients of minority race and ethnicity and lower socioeconomic status who have ovarian cancer have been reported to have less hospice use and more intensive end-of-life care.[13-18]

A limitation of the current literature discussing end-of-life outcomes among patients with ovarian cancer, however, is that previous studies included patients treated a decade ago and may not reflect current practice or only included patients found in the SEER database.[13,17,19] Texas, for example, has a higher proportion of black and Hispanic patients than found in the SEER data.[13,20,21] Our objective with this analysis was to identify variations in end-of-life care according to race and ethnicity among patients with ovarian cancer within a cohort that is not captured by SEER data.

PATIENTS AND METHODS

Cohort Ascertainment

The Texas Cancer Registry (TCR) is the fourth largest statewide population-based registry in the United States and collects information on patients with cancer treated in Texas.[20,21] The TCR meets the National Program of Cancer Registries, Centers for Disease Control and Prevention high-quality data standards and is Gold Certified by the North American Association of Central Cancer Registries. Data are collected according to standardized registry rules similar to SEER. Linking the TCR to claims data from Medicare provides information on demographics, comorbidities, tumor characteristics, and inpatient, outpatient, and hospice care received.

After approval by our Institutional Review Board, we selected patients from the TCR-Medicare database who were ≥ 66 years old at the time of death, whose only lifetime cancer was histologically confirmed ovarian cancer, and who died between 2000 and 2012, had at least 30 days from diagnosis to death, had at least 13 months of continuous Medicare A and B coverage (Medicare HMO excluded) before death, and resided within Texas (Fig 1). Of note, those patients who were excluded based on death within 30 days of diagnosis were similar to the larger cohort in terms of racial and ethnic makeup. The total number of eligible patients included in this analysis was 3,666.

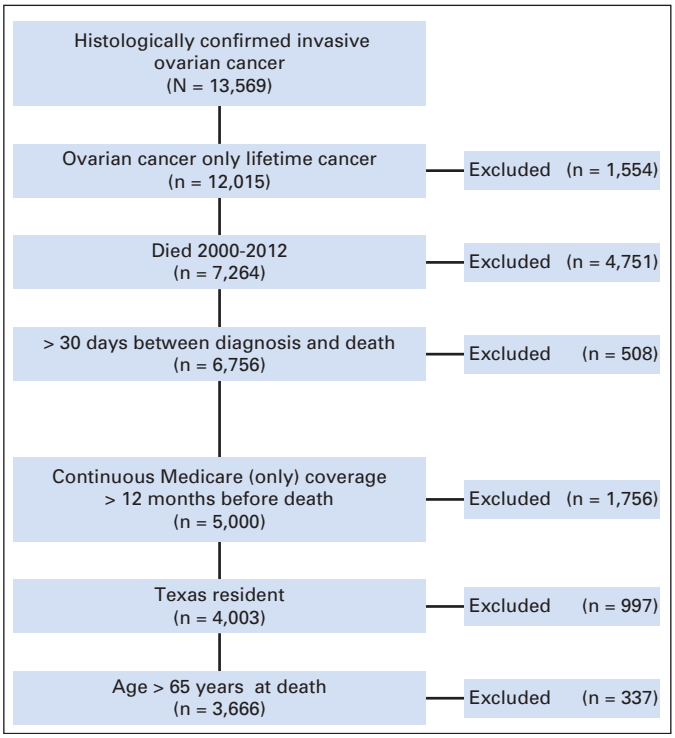


Fig 1. Patient selection diagram.

Model Covariates

Multivariate logistic regression was used to infer correlation between covariates and outcome variables. Covariates included in the regression model included year of death, age at death, length of time from diagnosis to death (months), Charlson comorbidity index, race/ethnicity, geographic categorization (urban *v* rural), stage at diagnosis, and educational and poverty level. Charlson comorbidity index values were determined from the 12-month period leading up to the final 30 days of life. Geographic categorization was defined according to previously published criteria.[19] Educational and poverty levels were divided into quartiles by the percentage of residents in each census tract older than 25 years of age with either less than a high school degree or income below the state-defined poverty level according to TCR census data.

Outcome Variables

Hospice outcomes. Outcome variables associated with hospice in these regression models included hospice enrollment before death, death while enrolled in hospice, hospice enrollment during the final 3 days of life, hospice enrollment as an inpatient versus outpatient, and more than one enrollment in hospice. Inpatient hospice referral was defined as occurring during a hospital admission or within 48 hours of discharge from a hospital, as previously published.[13,22] If a patient had more than one hospice enrollment, inpatient versus outpatient hospice referral was defined by the first episode of enrollment in hospice. The outcome of more than one hospice enrollment excluded patients who re-enrolled in hospice on the same day as unenrollment, because this could represent an administrative process of re-enrollment instead of a patient's decision to leave hospice.

Nonhospice outcomes. Other quality-of-care indicators included receipt of any chemotherapy in the final 14 days of life, more than one ER visit or hospital admission in the final 30 days of life, any ICU admission in the final 30 days of life, and receipt of an invasive procedure or a life-extending procedure in the final 30 days of life. Invasive procedures were considered to be surgeries requiring anesthesia, arterial line placement, central line placement, endoscopy, interventional radiology procedures, radiotherapy, and pelvic examinations with tissue sampling.[23] Previous definitions of invasive procedures had included paracentesis and thoracentesis; however, the authors excluded these procedures because they were considered to be acceptable palliative procedures during the final 30 days of life. Life-extending procedures were considered to be intubation, cardiopulmonary resuscitation, and placement of a feeding tube (although tubes placed solely for the purpose of venting to relieve discomfort were excluded).[13,24]

Model Information

Model diagnostics were performed including the Hosmer-Lemeshow goodness-of-fit test for each multivariate logistic regression modeling. A likelihood ratio statistic was calculated for race for each outcome following a χ^2 distribution with 3 degrees of freedom (Appendix Table A1, online only). A returned P value ≤ .05 from the χ^2 test was considered to be significant. Specific Current Procedural Terminology and International Classification of Diseases codes included in this analysis to define invasive procedures, life-extending procedures, ICU and ER visits, and receipt of chemotherapy are available in Appendix Table A2, online only. SAS version 9.3 (SAS Institute, Cary, NC) was used to perform the statistical analysis.

RESULTS

Of the 3,666 patients who met inclusion criteria for this analysis, there were 2,819 (77%) white, 553 (15%) Hispanic, 256 (7%) black, and 38 (1%) other patients. Additional notable characteristics were that 48% of patients were ≤ 75 years of age, 69% of

patients had advanced disease, 74% had a Charlson comorbidity index score of 0 or 1, and 79% lived in urban settings (Table 1).

Of the 3,666 patients included in the cohort, 2,642 (72%) were enrolled in hospice at some point before death. However, only 2,344 (64%) died while enrolled in hospice, and 248 (9.4%) of those patients who enrolled in hospice did so in the last 3 days of life. There were 298 (11.3%) hospice enrollees who unenrolled in hospice before death. The median time in hospice before death was 20 days. Of those patients who enrolled in hospice at some point before death, 530 (13%) enrolled in hospice more than once, and 1,403 (49%) patients enrolled in hospice as an inpatient instead of as an outpatient. There were 381 (10%) patients who experienced more than one ER visit, 505 (14%) who experienced more than one hospital admission, 593 (16%) who experienced an ICU admission, 848 (23%) who received an invasive procedure, and 418 (11%) who received life-continuing care during the final 30 days of life. In addition, 357 (10%) received chemotherapy in the final 14 days of life. Figure 2 reviews the percentage of each race and ethnicity experiencing the outcomes listed above.

After controlling for year of death, age at death, stage, comorbidity index score, educational level, poverty level, and geographic categorization of residence, there were several outcomes that differed by race and ethnicity. Patients with ovarian cancer of Hispanic ethnicity (odds ratio [OR], 0.78; 95% CI, 0.62 to 0.97; $P = .03$) and black (OR, 0.74; 95% CI, 0.55 to 0.98; $P = .04$) race were less likely to enroll in hospice compared with white patients. Hispanic (OR, 0.76; 95% CI, 0.61 to 0.94; $P = .01$) and black (OR, 0.66; 95% CI, 0.50 to 0.88; $P = .004$) patients were also less likely to die in hospice compared with white patients. Patients of other or unknown race were more likely to enroll in hospice as an inpatient than an outpatient (OR, 3.26; 95% CI, 1.27 to 8.37; $P = .01$). Among those who died after enrolling in hospice, patients of other or unknown race were more likely to enroll in hospice during the last 3 days of life (OR, 4.92; 95% CI, 2.09 to 11.60; $P < .001$). No racial or ethnic groups were more likely than others to have multiple hospice enrollments before death. In addition, the patients who enrolled in hospice, but then did not die while enrolled in hospice, were similar in terms of race and ethnicity (224 [75.2%] white, 46 [15.4%] Hispanic, 27 [9.1%] black, and one other/unknown race [0.4%]; $P = .40$) to the overall population studied.

Hispanic patients (OR, 1.37; 95% CI, 1.05 to 1.78; $P = .02$) and other or unknown race patients (OR, 2.42; 95% CI, 1.20 to 4.90; $P = .01$) were more likely to be admitted to the ICU in the final 30 days of life. Being of black race was associated with having increased odds of more than one ER visit in the final 30 days of life (OR, 2.20; 95% CI, 1.53 to 3.16; $P < .001$). Those of black race were more likely to receive a life-extending procedure in the final 30 days of life (OR, 2.13; 95% CI, 1.50 to 3.04; $P < .001$). The outcomes of having more than one hospital admission in the final 30 days of life and receipt of chemotherapy in the final 14 days of life did not vary according to race. Details of the outcomes stated above are shown in Table 2.

Disparities also existed between women living in census tracts with higher versus lower percentages of poverty or higher versus lower levels of education and women living in rural versus urban locations. A higher percentage of poverty in a census tract was associated with decreased odds of having an ICU admission in the final 30 days of life. Lower educational levels in a census tract were associated with increased likelihood of inpatient hospice enrollment compared with outpatient enrollment. Women living in rural areas had decreased odds of having an ICU admission (OR, 0.78; 95% CI, 0.61 to 0.998; $P = .049$), receiving a life-extending procedure (OR, 0.72; 95% CI, 0.54 to 0.97; $P = .03$), and undergoing an invasive procedure (OR, 0.74; 95% CI, 0.59 to 0.93; $P = .01$) in the final 30 days of life compared with women living in urban areas.

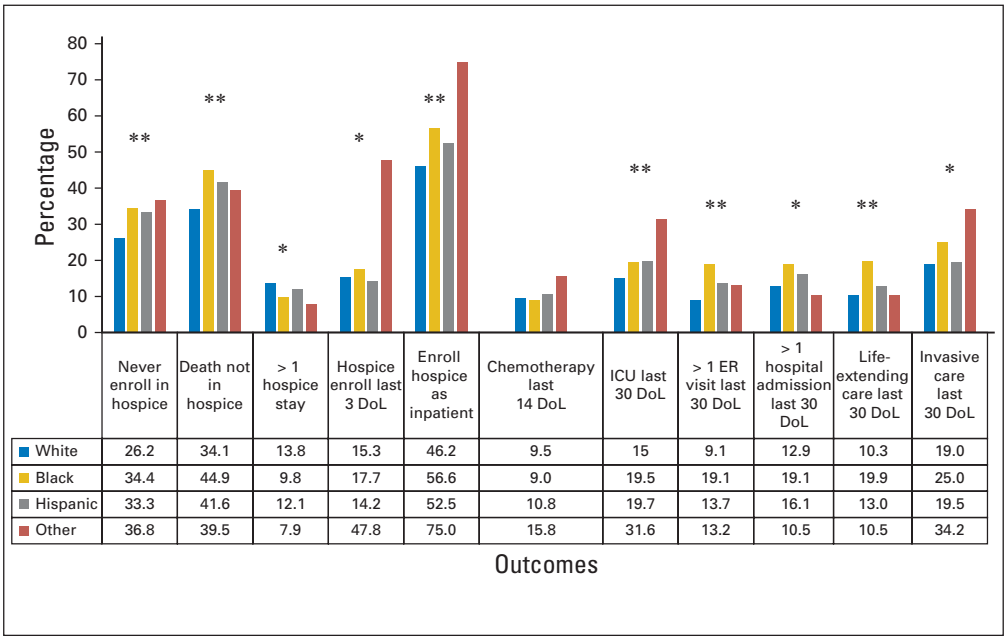
A sensitivity analysis (Appendix Table A3, online only) was performed to assess the robustness of these results. Patients whose cause of death was not listed as ovarian cancer were removed from the cohort and the outcomes reassessed. Black race remained associated with increased odds of dying while not enrolled in hospice, visiting the ER more than once, and receiving a life-extending procedure in the final 30 days of life. Hispanic race remained associated with being more likely to experience an ICU admission during the final 30 days of life.

Table 1. Demographic Characteristics of Cohort

Characteristic	No. (%)
Year of death	
2000	216 (5.9)
2001	224 (6.1)
2002	271 (7.4)
2003	307 (8.4)
2004	317 (8.7)
2005	339 (9.3)
2006	292 (8.0)
2007	306 (8.4)
2008	300 (8.2)
2009	305 (8.3)
2010	266 (7.3)
2011	270 (7.4)
2012	253 (6.9)
Age at death, years	
66-70	788 (21.5)
71-75	846 (23.1)
76-80	827 (22.6)
> 80	1,205 (32.9)
Race	
Non-Hispanic white	2,819 (76.9)
Hispanic	553 (15.1)
Non-Hispanic black	256 (7.0)
Other/unknown	38 (1.0)
Stage at diagnosis	
Localized	252 (6.9)
Regional	561 (15.3)
Advanced	2,537 (69.2
Unknown	316 (8.6)
Months from diagnosis to death, median	26
Charlson comorbidity index	
0-1	2,712 (74.0)
> 1	954 (26.0)
Geographic category	
Urban	2,890 (78.8)
Rural	776 (21.2)

DISCUSSION

Our results suggest that important disparities in use of end-of-life care persist among racial and ethnic minorities. Nonwhite patients were more likely to experience more intensive care in the last month of life and to be admitted to the ICU, have more than one ER visit, receive invasive care, and undergo a life-extending



	Never enroll in hospice	Death not in hospice	> 1 hospice stay	Hospice enroll last 3 DoL	Enroll hospice as inpatient	Chemotherapy last 14 DoL	ICU last 30 DoL	> 1 ER visit last 30 DoL	> 1 hospital admission last 30 DoL	Life-extending care last 30 DoL	Invasive care last 30 DoL
White	26.2	34.1	13.8	15.3	46.2	9.5	15	9.1	12.9	10.3	19.0
Black	34.4	44.9	9.8	17.7	56.6	9.0	19.5	19.1	19.1	19.9	25.0
Hispanic	33.3	41.6	12.1	14.2	52.5	10.8	19.7	13.7	16.1	13.0	19.5
Other	36.8	39.5	7.9	47.8	75.0	15.8	31.6	13.2	10.5	10.5	34.2

Fig 2. Percentage of each race/ethnicity experiencing outcome. DoL, days of life; ER, emergency room; ICU, intensive care unit. *Significant to $P < .05$, **Significant to $P < .001$.

procedure in the final 30 days of life. Each of these metrics has been identified by the ASCO Quality Oncology Practice Initiative, the Physician Consortium for Performance Improvement, and the National Quality Forum as medical care with unclear benefit to patients near the end of life and recommended to be minimized when possible.[1-3] Fairfield et al[17] found that among women who died of ovarian cancer from 2001 to 2007, nonwhite women were 44% more likely than white women to not enroll in hospice before death. Our analysis included data up to 2012 and still found that Hispanic and black patients were less likely to enroll in hospice before death compared with white women. Avoiding invasive care and focusing on more palliative goals near the end of life can not only avoid physical discomfort but also potentially bring greater satisfaction to patients and family members.[25] Interestingly, we found that among the subgroup of patients who enrolled in hospice but did not die while enrolled in hospice, there were no racial disparities. There is little medical literature addressing this patient population, and it is an area for future investigation.

Our analysis also assessed what differences, if any, existed between minorities in terms of end-of-life care. The racial and ethnic diversity present in Texas allows for a comparison of practices between black and Hispanic patients rather than only comparing white and nonwhite patients. Both black and Hispanic patients were less likely than white patients to enroll and die in hospice. Black patients, however, were also more likely to visit the ER more than once or receive a life-extending procedure in the final 30 days of life, whereas Hispanic patients were more likely to be admitted to an ICU.

Compared with the number of outcomes affected by race and ethnicity, we found that relatively few outcomes varied by income or educational level or geographic categorization. Although other studies reported disparities in hospice enrollment among patients with cancer on the basis of socioeconomic status, our cohort did not reflect this.[17,18,26] Geographic location is known to affect end-of-life care in other disease sites but has not previously been reported to affect patients with ovarian cancer.[16,17,27,28] The variation found in our study of women living in rural areas that were less likely to have an ICU admission or life-extending or invasive procedures may reflect limited access to care for more rural patients, but further research is needed to explore these findings.

When compared with other publications evaluating care at the end of life for patients with ovarian cancer, our percentages of patients experiencing outcomes related to hospice and end-of-life care are similar. Other studies of patients with ovarian cancer found that 26% to 50% of patients were never referred to hospice, whereas in our cohort 28% were never referred to hospice.[8,12,17] Our reported ICU admission rate during the final 30 days of life, the rates of multiple ER visits, hospital admissions, receipt of chemotherapy, life-extending procedures, or referral to hospice as an inpatient are relatable to previously reported rates.[8,12]

One of the limitations of our analysis is that this is an assessment of a single state, and the results may not be generalizable to the rest of the United States. We also limited the analysis to those patients with Medicare as their sole insurance provider and excluded patients with private insurances. Furthermore, as this is a single disease site, extrapolating these results to other disease sites must be done with caution. There are also inherent limitations in assessing outcomes within a 30-day period before death, because this can only be assessed retrospectively. In addition, it is difficult to fully adjust for educational and socioeconomic status with census-level data instead of individual patient data. Finally, using claims data is imperfect, because usage of resources is inferred, but the details of the care received are unknown. An example of this is the inference of referral to hospice occurring based on patient usage. However, the details of the referral and enrollment process to hospice are unknown.

Despite the above, our analysis also has several important strengths. The sample size of 3,666 patients is adequate for robust multivariate analysis. Furthermore, our cohort had a larger proportion of black and Hispanic patients than in other publications evaluating end-of-life care patterns among patients with ovarian cancer. Because of this, we were able to report outcomes for black and Hispanic ethnicity separately instead of only reporting white versus nonwhite. In addition, a possible confounder when examining

Table 2. Multivariate Results of End-of-Life Outcomes

Independent Variables	Enroll in Hospice	Die in Hospice	> 1 Hospice Enrollment	Hospice Enrollment Final 3 DoL	Hospice Enrollment as Inpatient	Chemotherapy Last 14 DoL	ICU Last 30 DoL	>1 ER Visit Last 30 DoL	>1 Hospital Admission Last 30 DoL	Life-Extending Procedure	Invasive Procedure
Black	**0.74 (0.55 to 0.98) *P* = .04**	**0.66 (0.50 to 0.88) *P* = .004**	0.83 (0.53 to 1.29) *P* = .40	1.23 (0.76 to 1.99) *P* = .94	1.25 (0.89 to 1.75) *P* = .19	0.81 (0.51 to 1.30) *P* = .38	1.34 (0.95 to 1.90) *P* = .10	**2.20 (1.53 to 3.16) *P* < .001**	1.38 (0.97 to 1.96) *P* = .07	**2.13 (1.49 to 3.04) *P* < .001**	1.23 (0.90 to 1.70) *P* = .20
Hispanic	**0.78 (0.62 to 0.97) *P* = .03**	**0.76 (0.61 to 0.94) *P* = .01**	0.94 (0.66 to 1.29) *P* = .70	0.99 (0.68 to 1.43) *P* = .40	1.16 (0.90 to 1.48) *P* = .25	1.15 (0.82 to 1.61) *P* = .42	**1.37 (1.05 to 1.78) *P* = .02**	1.33 (0.97 to 1.83) *P* = .08	1.17 (0.88 to 1.56) *P* = .28	1.31 (0.96 to 1.80) *P* = .09	0.94 (0.72 to 1.22) *P* = .62
Other/unknown race	0.56 (0.28 to 1.10) *P* = .09	0.69 (0.35 to 1.35) *P* = .27	0.51 (0.15 to 1.69) *P* = .27	**4.92 (2.09 to 11.60) *P* < .001**	**3.26 (1.27 to 8.37) *P* = .01**	1.94 (0.79 to 4.80) *P* = .15	**2.42 (1.20 to 4.90) *P* = .01**	1.34 (0.51 to 3.53) *P* = .56	0.84 (0.29 to 2.40) *P* = .74	0.95 (0.33 to 2.73) *P* = .93	2.10 (1.05 to 4.19) *P* = .04*
Hosmer-Lemeshow goodness of fit, *P*	.16	.30	.57	.66	.75	.80	.75	.90	.25	.22	.85

NOTE. All logistic regression analyses were adjusted with the following covariates: year of death, age at death, time from diagnosis to death, Charlson comorbidity index score, disease stage at diagnosis, educational level by census tract, poverty level by census tract, and geographic categorization of rural versus urban. All values shown are the odds ratio (95% CI) and *P* value. White race was used as the reference value. Values in bold are significant at $P < .05$.

Abbreviations: DoL, days of life; ER, emergency room; ICU, intensive care unit.

*As shown in Appendix Table A1, the overall likelihood ratio for this outcome was not significant at $P = .10$.

utilization patterns of patients during the end of life has been that certain diseases are highly associated with lower socioeconomic status, living in urban areas, or being of a racial minority, possibly due to genetic, occupational, nutritional, and other pathways. This type of selection bias can be difficult to control for even with sophisticated statistical methodology. In this analysis, we only examined patients with ovarian cancer. By choosing to solely evaluate patients with ovarian cancer, we avoided the possible bias associated with other disease sites caused by factors highly correlated with socioeconomic status.

In conclusion, our analysis confirmed that, irrespective of other sociodemographic factors, patients of black and Hispanic racial and ethnic backgrounds were less likely to meet end-of-life quality-care metrics. Our analysis cannot determine the driving factors behind these patterns of care. It is unknown to what extent the patient and the provider separately contributed to outcomes where the patient did not enroll in hospice or received invasive and aggressive care during the end of life. It is also unclear to what extent a distrust of the medical establishment by nonwhite patients could contribute to these outcomes.[29] Likely, efforts at education could benefit patients, caregivers, and providers. More investigation is needed to determine not only how to best reduce the overall number of patients with ovarian cancer who receive aggressive and invasive care but also how to lessen the disparity of who receives more aggressive and invasive care. With regard to end-of-life care for patients with ovarian cancer, less may be more. However, this is an area with a definite need for continued evaluation and performance improvement. Importantly, it has yet to be established from the perspective of a patient with ovarian cancer what type of care is valued at the end of life and how these perspectives may or may not vary by race and ethnicity.

AUTHORS' DISCLOSURES OF POTENTIAL CONFLICTS OF INTEREST

Disclosures provided by the authors are available with this article at jco.org.

AUTHOR CONTRIBUTIONS

Conception and design: Jolyn S. Taylor, Suja S. Rajan, Larissa A. Meyer, Lois M. Ramondetta, Diane C. Bodurka, David R. Lairson, Sharon H. Giordano
Data analysis and interpretation: All authors
Manuscript writing: All authors
Final approval of manuscript: All authors
Accountable for all aspects of the work: All authors

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Affiliations

Jolyn S. Taylor, **Ning Zhang**, **Larissa A. Meyer**, **Lois M. Ramondetta**, **Diane C. Bodurka**, and **Sharon H. Giordano**, The University of Texas MD Anderson Cancer Center; and **Suja S. Rajan** and **David R. Lairson**, The University of Texas School of Public Health, Houston, TX.

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Jolyn S. Taylor
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Suja S. Rajan
No relationship to disclose

Ning Zhang
No relationship to disclose

Larissa A. Meyer
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Lois M. Ramondetta
No relationship to disclose

Diane C. Bodurka
No relationship to disclose

David R. Lairson
No relationship to disclose

Sharon H. Giordano
No relationship to disclose

Appendix

Table A1. Likelihood Ratio Statistics for Race

Likelihood Ratio Statistic Test	Enroll in Hospice	Die in Hospice	>1 Hospice Enrollment	Hospice Enrollment Final 3 DoL	Hospice Enrollment as Inpatient	Chemotherapy Last 14 DoL	ICU Last 30 DoL	> 1 ER Visit Last 30 DoL	> 1 Hospital Admission Last 30 DoL	Life-Extending Procedure	Invasive Care
Maximized log-likelihood (nested model, omitting race)	4,220.41	4,642.94	2,763.069	1,987.064	3,585.559	2,257.33	3,186.44	2,380.303	2,889.006	2,541.914	3,541.576
Maximized log-likelihood (full model, including race)	4,210.73	4,630.04	2,760.916	1,974.343	3,576.37	2,253.68	3,175.27	2,363.038	2,885.264	2,525.427	3,535.295
Scaled difference in the maximized log-likelihood	9.675	12.894	2.153	12.721	9.189	3.652	11.163	17.265	3.742	16.487	6.281
P	.02	.005	.54	.005	.03	.3	.01	< .001	.29	< .001	.10

Abbreviations: DoL, days of life; ER, emergency room; ICU, intensive care unit.

Table A2. Medicare Claims Codes for Invasive Care Treatments or Events

Treatment or Events	Sources	Code(s)
Intensive care unit admission	CPT/HCPCS	'99291', '99292', '32000', '32002', '32020', '31500'
Emergency room visit	CPT/HCPCS	'99281', '99282', '99283', '99284', '99285'
	Revenue center code	0450-0459, 0981
	Place of service code	23
Life-extending procedures		
Cardiopulmonary resuscitation	ICD 9 procedure codes	'9293'
	CPT/HCPCS	'92950'
Feeding tube placement	ICD 9 procedure codes	'431', '432', exclude 96.07
	CPT/HCPCS	'43246', '43572', '43750', '43752', '43760', '43761', '43830', '43831', '43832', '43870', '49440', '74340', '74350'
Insertion of a breathing tube for assisted ventilation	ICD 9 procedure codes	'311', '312', '967', '9671', '9672', 9601-9605
	CPT/HCPCS	'31500'
Invasive procedures		
Arterial line placement	ICD 9 procedure codes	'3891'
	CPT/HCPCS	'36620', '36625'
Central line placement	ICD 9 procedure codes	'3893', '3897'
	CPT/HCPCS	'36556', '36558', '36561', '36563', '36565', '36566', '36578', '36580', '36582', '36583'
Endoscopy	ICD 9 procedure codes	'3321', '3322', '3323'
	CPT/HCPCS	44388-44397, 45330-45345, 45378-45392, 622', '31623', '31624', '31643', '43200', '43202', '43219', '43220', '43226', '43235', '43239', '43241', '43246', '43248', '43249', '43456', '43458', '91110'
Interventional radiology procedures	CPT/HCPCS	35470-35476, 35490-35495, 36215-36218, 36245-36248, 37184-37188, 37201-37206, 75660-75685, 75992-75996, 77001-77003, 77011-77014, 79005-79999, '36000', '36005', '36010', '36011', '36012', '36100', '36120', '36140', '36145', '36160', '36200', '36299', '36870', '37195', '37210', '37215', '37216', '37620', '61624', '61626', '61630', '61635', '75625', '75630', 75650', '75658', '75705', '75710', '75716', '75722', '75724', '75726', '75731', '75733', '75736', '75756', '75790', '75820', '75822', '75825', '75827', '75831', '75833', '75840', '75842', '75860', ' 75870', '75872', '75880', '75889', '75891', '75894', '75896', '75898', '75940', '75960', '75961', '75962', '75964', '75966', '75968', '75978', '77021', '77022', '77031', '77032'
Pelvic examinations with tissue sampling	CPT/HCPCS	'57454', '57455', '57456', '57460', '57461', '57500', '57505', '57520', '57522', '58100', '58110', '57100'
Radiotherapy	CPT/HCPCS	77371-77373, 77401-77423, 77427-77499, 77520-77525, 77600-77615, 77750-77799, '55920', '57155', '58346', '61793', '77399', '77620', '79005', '79101', '79200', '79300', '79403', '79440', '79445', '79999', '92974'
Surgeries requiring anesthesia	CPT/HCPCS	00100-00104, 00145-00148, 00210-00222, 00540-00550, 00560-'00567, 00860-00873, 00920-00930, 01920-01926, 01930-01936, 01951-01953, 01960-01969, 01990-01996, '00120', '00124', '00126', '00140', '00142', '00144', '00160', '00162', '00164', '00170', '00172', '00174', '00176', '00190', '00192','00300', '00320', '00322', '00326', '00350', '00352', '00400', 00402', '00404', '00406', '00410', '00420', '00450', '00452', '00454', '00470', '00472', '00474', '00500', '00520', '00522', '00524', '00528', '00529', '00530', '00532', '00534', '00537', '00539', '00580', '00600', '00604', '00620', '00622', '00625', '00626', '00630', '00632', '00634', '00635', '00640', '00670', '00700', '00702', '00730', '00740', '00750', '00752', '00754', '00756', '00770', '00790', '00792', '00794', '00796', '00797,' 00800', '00802', '00810', '00820', '00830', 00832', '00834', '00836', '00840', '00842', '00844', '00846', '00848', '00850', '00851', '00855', '00857', '00880', '00882', '00884', '00900', '00902', '00904', '00906', '00908', '00910', '00912', '00914', '00916', '00918', '00932', '00934', '00936', '00938', '00940', '00942', '00944', '00946', '00948', '00950', '00952', '00955', '01000', '01110', '01112', '01120', '01130', '01140', '01150','01160', '01170', '01173', '01180', '01190', '01200', '01202', '01210', '01212', '01214', '01215', '01220', '01230', '01232', '01234', '01240', '01250', '01260', '01270', '01272', '01274', '01300', '01320', '01340', '01360', '01380', '01382', '01390', '01392', '01400', '01402', '01404', '01420', '01430', '01432', '01440', '01442', '01444', '01460', '01462', '01464', '01470', '01472', '01474', '01480', '01482', '01484', '01486', '01490', '01500', '01502', '01520', '01522', '01600', '01610', '01620', '01622', '01630', '01632', '01634', '01636', '01638', '01650', '01652', '01654', '01656', '01670', '01680', '01682', '01700', '01710', '01712', '01714', '01716', '01730', '01732',

(continued on following page)

Table A2. Medicare Claims Codes for Invasive Care Treatments or Events (continued)

Treatment or Events	Sources	Code(s)
		'01740', '01742', '01744', '01756', '01758', '01760', '01770', '01772', '01780', '01782', '01784', '01800', '01810', '01820', '01829', '01830', '01832', '01840', '01842', '01844', '01850', '01852', '01860', '01900', '01902', '01904', '01905', '01906', '01908', '01910', '01912', '01914', '01916', '01918', '01958'
	CPT/HCPCS exclusions	'00101', '00146', '00213', '00217', '00219', '00221', '00543', '00545', '00547', '00549', '00564', '00565', '00861', '00863', '00867', '00871', '00923', '00925', '00927', '00929', '01923', '01934', '01993', '01994'
Receipt of chemotherapy	ICD 9 diagnosis codes	V581, V662, V672
	ICD 9 procedure codes	'9925'
	Revenue center code	'0331', '0332', '0335'
	CPT/HCPCS	'J8520', 'J8521', 'J8530', 'J8560', 'J8600', 'J8610', 'J8999', J9000-J9999, 96400-96549, Q0083-Q0085, G0355-G0363, G0921-G0932
	CPT/HCPCS exclusions	'J9003', 'J9165', 'J9175', 'J9202', 'J9209', 'J9212', 'J9220', 'J9221', 'J9222', 'J9223', 'J9224', 'J9225', 'J9226', 'J9213', 'J9214', 'J9215', 'J9216', 'J9217', 'J9218', 'J9219', 'J9240', 'J9295', 'J9381', 'J9395'

Table A3. Sensitivity Analysis: Removal of Patients Whose Cause of Death Was Not Ovarian Cancer

Independent Variables	Enroll in Hospice	Die in Hospice	> 1 Hospice Enrollment	Hospice Enrollment Final 3 DoL	Hospice Enrollment as Inpatient	Chemotherapy Last 14 DoL	ICU Last 30 DoL	> 1 ER Visit Last 30 DoL	> 1 Hospital Admission Last 30 DoL	Life-Extending Procedure	Invasive Procedure
Black	0.74 (0.52 to 1.06) P = .10	**0.65 (0.47 to 0.91) *P* = .01**	0.94 (0.59 to 1.50) P = .81	1.59 (0.90 to 2.82) P = .11	1.07 (0.73 to 1.59) P = .73	1.07 (0.64 to 1.77) P = .80	1.39 (0.89 to 2.17) P = .15	**2.53 (1.62 to 3.96) *P* < .001**	**1.79 (1.19 to 2.70) *P* = .005**	**2.19 (1.39 to 3.46) *P* < .001**	1.24 (0.84 to 1.82) P = .29
Hispanic	0.83 (0.63 to 1.10) P = .19	0.81 (0.63 to 1.05) P = .11	1.04 (0.75 to 1.43) P = .83	1.27 (0.82 to 1.95) P = .29	1.32 (0.99 to 1.75) P = .06	1.18 (0.80 to 1.73) P = .40	**1.43 (1.01 to 2.02) *P* = .04**	**1.53 (1.05 to 2.25) *P* = .03**	**1.57 (1.12 to 2.20) *P* = .008**	1.08 (0.70 to 1.66) P = .72	0.88 (0.64 to 1.22) P = .45
Other/Unknown Race	0.50 (0.21 to 1.20) P = .12	0.59 (0.25 to 1.39) P = .22	0.60 (0.18 to 2.06) P = .42	**6.79 (2.24 to 20.58) *P* < .001**	**3.45 (1.07 to 11.10) *P* = .04**	2.54 (0.92 to 7.05) P = .07	2.20 (0.84 to 5.74) P = .11	0.97 (0.22 to 4.26) P = .97	0.80 (0.18 to 3.48) P = .77	0.79 (0.18 to 3.45) P = .75	2.11 (0.86 to 5.17) P = .10

NOTE. All logistic regression analyses were adjusted with the following covariates: year of death, age at death, time from diagnosis to death, Charlson comorbidity index score, disease stage at diagnosis, educational level by census tract, poverty level by census tract and geographic categorization of rural versus urban. All values shown are the odds ratio (95% CI) and P value. White race was used as the reference value. Values in bold are significant at $P < .05$.