Diversity and Disparities in Musculoskeletal Care, Workforce, and Education
Guest Editors: Kimberly J. Templeton MD and Kris Radcliff MD

Are There Racial or Socioeconomic Disparities in Ambulatory Outcome or Survival After Oncologic Spine Surgery for Metastatic Cancer? Results From a Medically Underserved Center

Rafael De la Garza Ramos MD[1,2] [ORCID]**, Kainaat Javed BS[1], Jessica Ryvlin BS[1], Yaroslav Gelfand MD[1,2],**
Saikiran Murthy DO[1,2], Reza Yassari MD[1,2]

Abstract

Background Disparities among patients with cancer are well documented. Recent studies suggest these disparities also affect patients undergoing metastatic spinal tumor surgery. However, it is unclear whether social factors are associated with ambulatory outcomes or overall survival.

Questions/purposes In patients undergoing metastatic spinal tumor surgery, (1) Are race, Social Vulnerability Index (SVI) score, or insurance status associated with a lower likelihood of postoperative ambulation? (2) Are race, SVI score, or insurance status associated with shorter overall survival?

Methods Between April 2012 and June 2021, we surgically treated 148 patients for metastatic cord compression or spinal mechanical instability because of cancer. Inclusion criteria were patients with complete demographic, social, oncologic, and follow-up data and patients who were followed until death or for at least 3 months postoperatively. Based on these criteria, 12% (18 of 148) were excluded because they had incomplete data and another 7% (11 of 148) were excluded because they were lost before the minimum study follow-up interval, leaving 80% (119) for analysis. Collected social data included self-reported race (White, Black, Hispanic or Latino, or other), SVI score, and primary insurance (Medicare, Medicaid, or private). The median age of the group was 62 years (interquartile range [IQR] 53 to 70 years), and 58% of patients were men (69 of 119). The race distribution was 45% Black (54 of 119), 32% Hispanic or Latino (38 of 119), 16% White (19 of 119), and 7% other (eight of 119). The median SVI score was 89.8 (IQR 73.8 to 98.5), and 74% of patients (88) were categorized as having high vulnerability. The insurance distribution was as follows: Medicare: 43%, Medicaid: 36%, and private insurance: 21%. The primary outcome variable was complete inability to ambulate postoperatively and the secondary outcome was median overall survival. Exploratory data analysis, univariate and multivariate logistic regression, and univariate and multivariate Cox regression analyses were performed.

Results After controlling for race, SVI score, insurance status, primary cancer, and modified Bauer score, the only

[1]Spine Research Group, Montefiore Medical Center, Albert Einstein College of Medicine, New York, NY, USA

[2]Department of Neurological Surgery, Montefiore Medical Center, Albert Einstein College of Medicine, New York, NY, USA

R. De la Garza Ramos ✉, 3316 Rochambeau Avenue, 3rd Floor, New York, NY 10467, USA, Email: rdelag@montefiore.org

factor independently associated with postoperative non-ambulation was preoperative nonambulatory status (odds ratio 59.3 [95% confidence interval (CI) 13.2 to 266.1]; p < 0.001). After controlling for variables such as performance status, BMI, primary cancer, modified Bauer score, and insurance status, factors independently associated with survival included Eastern Cooperative Oncology Group performance status (hazard ratio [HR] 1.4 [95% CI 1.1 to 2.0]; p = 0.03), prostate cancer (HR 0.4 [95% CI 0.1 to 0.9]; p = 0.03), and hematologic cancer (HR 0.3 [95% CI 0.1 to 0.8]; p = 0.02). Race, SVI score, and insurance status were not associated with overall survival.

Conclusion. In this study, we found no difference in am-bulatory outcome for patients based on their race, SVI score, or insurance status. Likewise, no differences in postoperative survival were found. These findings suggest that despite differences in presentation or short-term out-come reported in other investigations, the social factors we explored were not associated with the likelihood of a pa-tient being nonambulatory postoperatively or shorter sur-vival after spinal tumor surgery. Research studies that analyze race as a covariate of interest should take care to explore metrics of socioeconomic deprivation (such as the SVI score) to avoid drawing misleading conclusions.

Level of Evidence Level III, therapeutic study.

Introduction

The spine is the most common site for skeletal metastases. Every year, an estimated 120,000 patients receive a diagnosis of spinal metastasis in the United States, with 20% of patients presenting with spinal cord compression [3]. Metastatic spine disease causing cord compression can result in impaired ambulation, but timely intervention has been shown to im-prove postoperative ambulatory rates and survival [14]. Nonetheless, inequalities based on race and socioeconomic status in the management and short-term outcome of patients with metastatic spine disease have been reported [5-7, 9].

Patient factors such as race or ethnicity, socioeconomic deprivation, and geographic location are the main mecha-nisms underlying cancer health disparities [13]. Education and literacy are also important, including the ability of pa-tients with cancer to understand and recognize symptoms of spinal metastasis such as back pain or leg numbness or weakness. When investigating disparities, it is important to consider all parameters to account for potential confounding. Dasenbrock et al. [5] found higher in-hospital mortality rates for patients with Medicaid insurance undergoing oncologic spine surgery than for privately insured patients, but these differences became negligible when controlling for acuity of presentation. However, a recent national database in-vestigation found that Black patients were less likely to undergo surgical intervention, even after controlling for

insurance status and income, than White patients [6]. Additionally, investigations of disparities in postoperative ambulation rates and long-term overall survival (OS) have been limited.

We therefore asked, in patients undergoing metastatic spinal tumor surgery, (1) Are race, Social Vulnerability Index (SVI) score, or insurance status associated with a lower likelihood of postoperative ambulation? (2) Are race, SVI score, or insurance status associated with shorter OS?

Patients and Methods

Study Design and Setting

This was a single-center, retrospective, comparative study at an urban teaching hospital in a major metropolitan area. Our hospital is associated with a National Cancer Institute–designated cancer center. Our neurosurgical spine database was queried in March 2022 to identify our potential study cohort.

Patients

Between April 2012 and June 2021, we surgically treated 148 patients for metastatic cord compression or spinal me-chanical instability for cancer. Inclusion criteria were pa-tients with complete demographic, social, oncologic, and follow-up data and patients who were followed until death or for at least 3 months postoperatively. Based on these criteria, 12% (18) were excluded because they had incomplete data and another 7% (11) were excluded because they were lost before the minimum study follow-up period, leaving 80% (119 of 148) for analysis in this study. No differences were found in the rate of loss to follow-up or incomplete data between ambulatory and nonambulatory status.

Among the final analytic sample, indications for surgery included metastatic spinal cord compression in 85% (101 of 119) of patients, potentially unstable lesions as assessed by the Spinal Instability Neoplastic Score in 66% (79) of patients, and unstable lesions in 28% (33) of patients. Patients were eligible for surgical decompression if they presented within 48 hours of motor weakness or impaired ambulation; internal fixation was indicated for potentially unstable and unstable lesions as determined by the Spinal Instability Neoplastic Score.

Variables

Collected patient data included age, gender, self-reported race (White, Black, Hispanic or Latino, or other [Middle Eastern, Asian, or Southeast Asian]), Eastern Cooperative

Oncology Group performance status, BMI, presence of back pain at presentation, Frankel grade at presentation, nonambulatory status at presentation (complete inability to ambulate even with assistance), primary cancer (lung, breast, prostate, kidney, colorectal, hematologic, or other), modified Bauer score, de novo cancer diagnosis, presence of pathologic vertebral compression fracture, Spinal Instability Neoplastic Score, and emergency-type procedure (performed within 24 hours of admission).

The SVI score and primary insurance status at the time of surgery (Medicare, Medicaid, or private) were also obtained for each patient. The SVI score was ascertained from the Centers for Disease Control and Prevention's website (https://svi.cdc.gov/map.html); the year immediately preceding the date of surgery was used as well as the patient's domicile at that time. This index is a measure of the level of socioeconomic deprivation of a geographic area and ranges from 0 to 1, with higher values representing more deprivation. The index is further categorized into low, moderate, and high vulnerability defined by the Centers for Disease Control based on its percentile distribution. The SVI score is also composed of four distinct subthemes, each of which is scored from 0 to 1: socioeconomic status, household composition and disability, minority status and language, and housing type and transportation.

Participants' Baseline Data

A total of 119 patients were included in this study (Table 1). The median age of the group was 62 years (interquartile range [IQR] 53 to 70), and 58% (69 of 119) of patients were men. The race distribution was 45% (54 of 119) Black, 32% (38 of 119) Hispanic or Latino, 16% (19 of 119) White, and 7% (8 of 119) other (three Southeast Asian patients, two Asian patients, two Middle Eastern patients, and one other who declined to state their race or ethnicity). The median Eastern Cooperative Oncology Group performance status was 2 (IQR 1 to 3), and the mean BMI was 27 ± 6 kg/m^2. Among all patients, 22% (26 of 119) presented with Frankel Grades A to C, but 30% (36) were not ambulatory at all at presentation. The nonambulatory proportions for Black, Hispanic or Latino, White, and other-race patients were 39% (21 of 54), 26% (10 of 38), 21% (four of 19), and 13% (one of eight), respectively. The three most common primary cancers were hematologic in 22% (26 of 119) of patients, other in 20% (24 of 119), and prostate in 18% (21 of 119). For 37% (44 of 119) of patients, this was the first presentation of cancer, and 49% (58 of 119) had a pathologic vertebral compression fracture. A total of 28% (33 of 119) of procedures were performed emergently.

The median SVI score was 90 (IQR 74 to 99), and 74% (88 of 119) of patients were categorized as having high vulnerability (Table 2). The insurance distribution was as

follows: Medicare: 43% (51), Medicaid: 36% (43), and private insurance: 21% (25).

Primary and Secondary Study Outcomes

The primary outcome variable was complete inability to ambulate postoperatively (which we refer to as nonambulatory). Patients were dichotomized into nonambulatory or ambulatory; if a patient could ambulate at all, even with assistive devices, that patient was categorized as ambulatory for the analysis to reduce the potential for error. A patient's ability to ambulate was evaluated daily using physical therapy and neurosurgery progress notes while patients were in the hospital. Postoperatively, ability to ambulate was ascertained from follow-up oncology or neurosurgery notes. Of the 28

Table 1. Baseline and oncologic characteristics (n = 119)

Parameter	Value
Age in years, median (IQR)	62 (53 to 70)
Men, % (n)	58 (69)
Race, % (n)	
White	16 (19)
Black	45 (54)
Hispanic/Latino	32 (38)
Other	7 (8)
ECOG performance status, median (IQR)	2 (1 to 3)
BMI in kg/m^2, mean $\pm$ SD	27 ± 6
Back pain, % (n)	82 (98)
Neurologic status, % (n)	
Frankel D-E	78 (93)
Frankel A-C	22 (26)
Nonambulatory at presentation, % (n)	30 (36)
Primary cancer, % (n)	
Breast	15 (18)
Lung	16 (19)
Prostate	18 (21)
Colorectal	5 (6)
Kidney	4 (5)
Hematologic	22 (26)
Other	20 (24)
Modified Bauer score, median (IQR)	2 (1 to 3)
De novo cancer diagnosis, % (n)	37 (44)
Pathologic vertebral compression fracture, % (n)	49 (58)
SINS, median (IQR)	11 (8 to 13)
Emergency procedure, % (n)	28 (33)

ECOG = Eastern Cooperative Oncology Group; SINS = Spinal Instability Neoplastic Score.

Table 2. Socioeconomic data (n = 119)

Parameter	Value
SVI, median (IQR)	90 (74 to 99)
Vulnerability category, % (n)	
Low	9 (11)
Moderate	17 (20)
High	74 (88)
SVI subthemes, median (IQR)	
Socioeconomic status	81 (56 to 94)
Household composition and disability	69.0 (45 to 86)
Minority status and language	91.9 (86 to 98)
Housing type and transportation	88 (75 to 96)
Primary insurance, % (n)	
Medicare	43 (51)
Medicaid	36 (43)
Private	21 (25)

SVI = Social Vulnerability Index.

patients who were nonambulatory postoperatively, 24 were nonambulatory at presentation and four patients experienced new weakness during the follow-up period (median follow-up 3.4 months [IQR 1.3 to 9.4 months]).

The secondary outcome measure was the median OS. This was evaluated in a time-to-event analysis, with postoperative day zero being defined as the time origin.

Ethical Approval

This study received institutional review board approval (IRB 2016-6896).

Statistical Analysis

All analyses were performed in Stata 16 IC (StataCorp). An exploratory data analysis was performed first. A univariate logistic regression analysis was done with nonambulatory status postoperatively as the dependent variable (Supplemental Table 1; http://links.lww.com/CORR/A961). The following variables were included in the univariate analysis: age, gender, race (White, Black, Hispanic or Latino, and other), BMI, back pain at presentation, nonambulatory status at presentation, primary cancer (breast, prostate, kidney, colorectal, hematologic, or other), modified Bauer score, de novo cancer diagnosis, presence of a pathologic vertebral compression fracture, Spinal Instability Neoplastic Score, SVI score, socioeconomic status score, household composition and disability score, minority group and language score, housing type and transportation score, Medicare primary insurance, Medicaid primary insurance, and private primary insurance. All factors with a p value less than 0.10 were then included in a multivariate logistic regression analysis. For the secondary outcome measure, OS, a univariate Cox regression analysis was performed with the same variables as in the logistic regression univariate analysis, with the addition to Eastern Cooperative Oncology Group performance status; hazard ratios with corresponding 95% confidence intervals are reported (Supplemental Table 2; http://links.lww.com/CORR/A962). Factors with a p value less than 0.10 were then included in a multivariate Cox proportional hazards model. Statistical significance was defined as a p value less than 0.05.

Results

Factors Associated With Nonambulatory Status Postoperatively

After controlling for race, SVI score, insurance status, primary cancer, and modified Bauer score, the only factor independently associated with postoperative non-ambulation was preoperative nonambulatory status (OR 59.3 [95% CI 13.2 to 266.1]; p < 0.001). Race, SVI score, and insurance type were not independently associated with ambulatory outcome (Table 3). Postoperatively, 24% (28 of 119) of patients were nonambulatory.

Table 3. Multivariate logistic regression of factors associated with nonambulatory status postoperatively

Parameter	OR	95% CI	p value
Black race	1.1	0.3 to 4.4	0.89
Nonambulatory at presentation	59.3	13.2 to 266.1	< 0.001
Hematologic cancer	0.3	0.03 to 2.5	0.25
Other cancer	3.7	0.7 to 19.4	0.13
Modified Bauer score	0.9	0.4 to 2.0	0.74
Household composition and disability	2.6	0.2 to 41.6	0.50
Medicaid	2.9	0.8 to 11.6	0.12

Table 4. Multivariate Cox regression analysis of factors associated with postoperative survival

Parameter	HR	95% CI	p value
ECOG performance status	1.4	1.1 to 2.0	0.03
BMI	1.0	0.9 to 1.0	0.32
Nonambulatory at presentation	1.4	0.7 to 2.7	0.37
Lung cancer	1.2	0.5 to 3.2	0.66
Prostate cancer	0.4	0.1 to 0.9	0.03
Hematologic cancer	0.3	0.1 to 0.8	0.02
Other cancer	1.2	0.7 to 2.5	0.69
Modified Bauer score	0.8	0.5 to 1.2	0.22
De novo cancer diagnosis	0.7	0.4 to 1.2	0.21
Pathologic vertebral compression fracture	1.6	0.9 to 2.7	0.11
Private insurance	0.5	0.2 to 1.00	0.05

ECOG = Eastern Cooperative Oncology Group.

Factors Associated With Overall Survival

The median OS for all patients was 23.4 months (95% CI 13.7 to 41.3). After controlling for variables such as performance status, BMI, primary cancer, modified Bauer score, and insurance status, we found that factors independently associated with survival included Eastern Cooperative Oncology Group performance status (HR 1.4 [95% CI 1.1 to 2.0]; p = 0.03), prostate cancer (HR 0.4 [95% CI 0.1 to 0.9]; p = 0.03), and hematologic cancer (HR 0.3 [95% CI 0.1 to 0.8]; p = 0.02). Race, SVI score, and insurance status were not associated with OS (Table 4)

Discussion

Disparities in oncologic surgery are well documented [8, 13]. Although cancer stage remains the most important prognostic indicator, social factors also contribute to limited access to screening, surgical interventions, and timely treatment [13]. For patients with metastatic spine disease, recent studies have found inequalities in clinical presentation, type of intervention, short-term complications, and discharge disposition [5-7, 9]. However, there are no studies we are aware of that have evaluated race and insurance status and adequately controlled for socioeconomic deprivation. As such, identifying how these disparities may manifest in patients with spinal metastases and whether they affect postoperative ambulation or survival is important as a first step toward providing equitable care. In this study, we found that race, SVI score, and insurance were not independently associated with ambulatory outcome or survival in our spinal oncology population after controlling for factors such as ambulatory status at presentation, modified Bauer score, or performance status. Although social factors

may be associated with disparities when examined individually, the lack of association after controlling for confounding suggests that patients are still receiving equitable care. In addition, research studies that analyze race as a covariate of interest should explore metrics of socioeconomic deprivation (such as the SVI score) to avoid drawing misleading conclusions.

Limitations

The main limitations of the study are the risk of selection and assessment bias. Our study was conducted in a mostly underserved population with a high proportion (84%) of patients who were non-White. About three-fourths of our patients were also considered highly vulnerable, as assessed by the SVI score, and nearly 80% were insured by Medicare or Medicaid. As such, it may be difficult to find differences in outcomes when most of the group is considered disadvantaged. However, every variable was examined individually in a detailed univariate analysis. The combined high percentage of Black and White patients (61%) compared with other races may have also resulted in a study that was underpowered to detect associations between other races and outcomes. Given that we only examined patients undergoing surgery, it is unclear whether there was also selection bias regarding the decision about who was a candidate for intervention; however, the racial distribution in our study is consistent with the demographics of our target population. Postoperative ambulation was ascertained from physical therapy and neurosurgical follow-up notes and not from objective gait testing. Our primary endpoint was a patient's complete inability to ambulate, which we believe was a more objective measure to assess than partially ambulatory (patients who may have ataxic gait requiring

assistance, for example). Some patients who died early might also have not had enough time to recover neurologically, and it is possible this resulted in an overestimation of a patient's inability to ambulate postoperatively.

Discussion of Key Findings

We found that after controlling for confounding variables such as being nonambulatory at presentation, primary cancer type, and modified Bauer score, no differences in postoperative nonambulation were found in terms of race, SVI score, or insurance status. A recent national database investigation of 145,809 admissions for metastatic spine disease found that Black patients had the highest likelihood of presenting with myelopathy and paralysis compared with people of other races, but unfortunately, no data on preoperative or postoperative ambulation were available for analysis [6]. Although we also found a higher rate of nonambulation preoperatively for Black patients than for White patients, our multivariable analysis found that race was not independently associated with ambulatory outcome after controlling for relevant confounding variables, such as socioeconomic deprivation as measured by the SVI score. This suggests that patients undergoing surgical decompression are still receiving equitable care and the likelihood of postoperative ambulation is equal irrespective of race, SVI score, or insurance, which is certainly encouraging. Nevertheless, 37% of our patients had spinal metastases at cancer diagnosis, 30% presented with a complete inability to ambulate, and 28% underwent emergency surgery. As such, efforts in timely screening and recognition of symptoms of spinal metastases are needed to prevent patients from presenting when their disease is at an advanced stage. Helpful strategies include addressing cultural or linguistic barriers to screening and diagnosis, promoting education at an institutional level, and establishing a practice system to identify patients with cancer at the highest risk of having spinal metastases (lung, breast, and prostate, for example) and keeping track of them [19].

Likewise, there were no associations of race, SVI score, or insurance status with postoperative OS. Dasenbrock et al. [5] examined 2154 patients aged 18 to 64 years who underwent metastatic spinal tumor surgery and found that patients with Medicaid insurance had higher odds of in-hospital mortality than patients with private insurance. However, these differences became negligible when adjusting for acuity of presentation, medical comorbidities, and hospital volume. Another study compared 30-day outcomes of 1053 White patients and 173 Black patients who underwent spinal tumor surgery, finding no difference in major complication rates, including 30-day mortality, in a multivariable analysis [7]. Although none of these studies examined overall survival beyond 30 days, our findings are consistent because social factors were not independently associated with survival.

Our findings revealed that a patient's inability to ambulate preoperatively was the only independent predictor of postoperative ambulation, consistent with previous findings [2]. On the other hand, performance status and primary tumor type were independent prognostic factors of survival, which is also consistent with previous research [4, 11]. Inequalities in cancer are often the result of limited screenings and access to care. More advanced stages of disease are consistently diagnosed in Black patients, who are also known to have lower cancer screening incidences [10, 12, 15, 16, 18, 20]. This reflects systemic issues in terms of access to and use of cancer care, which have been shown to disproportionately affect non-White people in the United States [10]. Patients of other races and patients with more severe socioeconomic deprivation are also more likely to access healthcare systems and providers with limited resources and access to specialists, including surgical referrals [1].

Also of importance is that studies have found differences in surgical use for patients with cancer. Steyerberg et al. [17] found a higher mortality rate among Black patients with esophageal cancer that was attributed to lower rates of operative treatment. This group of patients was less likely to be assessed by a surgeon and have more comorbid conditions. Although we do not have data on nonoperative patients with spinal tumors seen at our institution, potential differences in treatments warrant further investigation.

Conclusion

Preserving and preventing further loss of neurologic function is a main goal of oncologic spine surgery. In this study, we found no difference in ambulatory outcome for patients based on their race, SVI score, or healthcare insurance type. Likewise, no differences in postoperative survival were found. These findings suggest that despite differences in presentation or short-term outcome reported in other investigations, the social factors we explored were not associated with being nonambulatory postoperatively and are not associated with shorter survival after spinal tumor surgery. Research studies that analyze race as a covariate of interest should take care to explore metrics of socioeconomic deprivation (such as the SVI score) to avoid drawing misleading conclusions.

References

1. Bach PB, Pham HH, Schrag D, Tate RC, Hargraves JL. Primary care physicians who treat blacks and whites. *N Engl J Med*. 2004; 351:575-584.
2. Bakar D, Tanenbaum JE, Phan K, et al. Decompression surgery for spinal metastases: a systematic review. *Neurosurg Focus*. 2016;41:E2.
3. Berry-Candelario J, Bilsky MH, Laufer I, Goodwin CR, Barzilai O. Epidemiology of spinal metastatic disease. In: Ramakrishna

R, Magge RS, Baaj AA, Knisely JPS, eds. *Central Nervous System Metastases*. Springer; 2020:495-502.

4. Bollen L, Jacobs WCH, Van der Linden YM, Van der Hel O, Taal W, Dijkstra PDS. A systematic review of prognostic factors predicting survival in patients with spinal bone metastases. *Eur Spine J*. 2018;27:799-805.

5. Dasenbrock HH, Wolinsky JP, Sciubba DM, Witham TF, Gokaslan ZL, Bydon A. The impact of insurance status on outcomes after surgery for spinal metastases. *Cancer*. 2012;118:4833-4841.

6. De la Garza Ramos R, Benton JA, Gelfand Y, et al. Racial disparities in clinical presentation, type of intervention, and in-hospital outcomes of patients with metastatic spine disease: an analysis of 145,809 admissions in the United States. *Cancer Epidemiol*. 2020;68:101792.

7. De la Garza Ramos R, Choi JH, Naidu I, et al. Racial disparities in perioperative morbidity following oncological spine surgery. *Global Spine J*. Published online June 14, 2021. DOI: 21925682211022290.

8. Greenberg CC, Weeks JC, Stain SC. Disparities in oncologic surgery. *World J Surg*. 2008;32:522-528.

9. Hung B, Pennington Z, Hersh AM, et al. Impact of race on non-routine discharge, length of stay, and postoperative complications after surgery for spinal metastases. *J Neurosurg Spine*. 2021:1-8.

10. Islami F, Guerra CE, Minihan A, et al. American Cancer Society's report on the status of cancer disparities in the United States, 2021. *CA Cancer J Clin*. 2022;72:112-143.

11. Lei M, Liu Y, Yan L, Tang C, Liu S, Zhou S. Posterior decompression and spine stabilization for metastatic spinal cord compression in the cervical spine. A matched pair analysis. *Eur J Surg Oncol*. 2015;41:1691-1698.

12. Mayberry RM, Coates RJ, Hill HA, et al. Determinants of black/white differences in colon cancer survival. *J Natl Cancer Inst*. 1995;87:1686-1693.

13. Morris AM, Rhoads KF, Stain SC, Birkmeyer JD. Understanding racial disparities in cancer treatment and outcomes. *J Am Coll Surg*. 2010;211:105-113.

14. Patchell RA, Tibbs PA, Regine WF, et al. Direct decompressive surgical resection in the treatment of spinal cord compression caused by metastatic cancer: a randomised trial. *Lancet*. 2005;366:643-648.

15. Schwartz KL, Crossley-May H, Vigneau FD, Brown K, Banerjee M. Race, socioeconomic status and stage at diagnosis for five common malignancies. *Cancer Causes Control*. 2003;14:761-766.

16. Seeff LC, Nadel MR, Klabunde CN, et al. Patterns and predictors of colorectal cancer test use in the adult U.S. population. *Cancer*. 2004;100:2093-2103.

17. Steyerberg EW, Earle CC, Neville BA, Weeks JC. Racial differences in surgical evaluation, treatment, and outcome of locoregional esophageal cancer: a population-based analysis of elderly patients. *J Clin Oncol*. 2005;23:510-517.

18. Thornton JG, Morris AM, Thornton JD, Flowers CR, McCashland TM. Racial variation in colorectal polyp and tumor location. *J Natl Med Assoc*. 2007;99:723-728.

19. Winkfield KM, Regnante JM, Miller-Sonet E, Gonzalez ET, Freund KM, Doykos PM. Development of an actionable framework to address cancer care disparities in medically underserved populations in the United States: expert roundtable recommendations. *JCO Oncol Pract*. 2021;17:e278-e293.

20. Zhao BB, Kilbourne B, Stain SC, et al. Racial disparities and trends in use of colorectal procedures among Tennessee elderly (1996-2000). *Ethn Dis*. 2006;16:412-420.

Wolters Kluwer