

Racial and Ethnic Differences in Treatment and Survival Among Adults With Primary Extremity Soft-Tissue Sarcoma

Steve R. Martinez, MD¹
Anthony S. Robbins, MD, PhD²
Frederick J. Meyers, MD³
Richard J. Bold, MD¹
Vijay P. Khatri, MB, ChB¹
James E. Goodnight, Jr, MD, PhD¹

¹ Division of Surgical Oncology, University of California at Davis Cancer Center, Sacramento, California.

² California Cancer Registry, Public Health Institute, Sacramento, California.

³ Division of Hematology and Oncology, University of California at Davis Cancer Center, Sacramento, California.

The first and second authors contributed equally to this work.

Address for reprints: Steve R. Martinez, MD, University of California at Davis Cancer Center, 4501 X Street, Suite 3010, Sacramento, CA 95817; Fax: (916) 703-5267; E-mail: steve.martinez@ucdmc.ucdavis.edu

Received July 5, 2007; revision received September 10, 2007; accepted September 19, 2007.

BACKGROUND. Limb preservation is preferred to amputation for patients with extremity soft tissue sarcoma (ESTS). Disparities in the treatment and outcomes of several malignancies have been reported, but not for ESTS. The authors assessed racial/ethnic differences in patient- and tumor-specific characteristics, treatment, and disease-specific survival in a population of adults with ESTS.

METHODS. The Surveillance, Epidemiology, and End Results (SEER) database was used to identify 6406 adult patients with ESTS who were diagnosed and treated between 1988 and 2003. Patients were categorized into 1 of 4 racial/ethnic groups: whites, blacks, Hispanics, and Asians. Comparisons of treatment and disease-specific survival were conducted with regression models that adjusted for patient age, sex, SEER geographic region, extent of disease, tumor grade, tumor size, and histology.

RESULTS. Relative to whites, blacks received lower rates of adjuvant radiation with surgery (odds ratio [OR], 0.77; 95% confidence interval [95% CI], 0.66–0.90). Hispanics received significantly lower rates of limb-sparing surgery (OR, 0.76; 95% CI, 0.59–0.97). In a multivariate analysis controlling for patient age, sex, SEER geographic region, extent of disease, tumor grade, tumor size, and histology, blacks displayed a worse disease-specific survival (hazard ratio [HR] 1.39; 95% CI, 1.13–1.70), whereas Asians demonstrated superior disease-specific survival (HR, 0.67; 95% CI, 0.46–0.97).

CONCLUSIONS. There were significant racial/ethnic differences in treatment and survival among adults with ESTS. Compared with whites, survival was poorer for blacks but better for Asians. These disparities were not explained by differences in patient or tumor characteristics. *Cancer* 2008;112:000–000. © 2008 American Cancer Society.

KEYWORDS: soft tissue, extremity, sarcoma, disparities, race, ethnicity, limb-sparing, amputation, radiation.

Adult extremity soft tissue sarcomas (ESTS) are a rare and heterogeneous group of tumors. Approximately 9220 cases of soft tissue sarcoma will be diagnosed in 2007.¹ Of these, half will involve the upper or lower extremity.² Surgery remains the mainstay of treatment, particularly for small, superficial, and low-grade lesions. Limb preservation is preferred to amputation and remains the standard of care in the modern surgical treatment of ESTS.^{3,4} It is estimated that only 5% of patients with ESTS require an amputation because of anatomic factors.⁵ Radiation therapy, given either before or after surgical resection, has had a dramatic impact on the outcome of limb preservation, providing adequate local control in up to 91% of patients⁶ and achieving survival rates comparable to those

achieved with more radical surgery, such as amputation.⁶⁻⁸ Radiation therapy can be used to increase the rate of limb preservation without adversely affecting cancer-related mortality even in the most difficult cases, including those involving large ESTS (>5 cm), high-grade tumors, or those in close proximity to vital neurovascular structures.⁹⁻¹¹

Disparities in treatment and disease outcomes related to patient age, race, and ethnicity have been reported for several cancer types.¹²⁻¹⁷ Because of the rarity of ESTS, disparities in treatment and disease outcomes have not been well reported.¹⁸ Based on patterns of disparities noted with other malignancies, we hypothesized that blacks and Hispanics would have lower rates of radiation therapy and limb preservation than non-Hispanic whites, even when controlling for patient age, sex, Surveillance, Epidemiology, and End Results (SEER) geographic region, extent of disease, tumor size, tumor grade, and histology.

MATERIALS AND METHODS

The SEER database of the National Cancer Institute was used to identify a population of adult patients with ESTS. SEER currently collects cancer incidence and survival data from 17 population-based cancer registries that cover approximately 26% of the United States population. The current SEER registries consist of the states of Connecticut, Hawaii, Iowa, Kentucky, Louisiana, New Jersey, New Mexico, and Utah; the metropolitan areas of Atlanta, Detroit, San Francisco-Oakland, Seattle-Puget Sound, and San Jose-Monterey; and the Alaska Native Tumor Registry, rural Georgia, Greater California, and Los Angeles County. SEER registries routinely collect data on patient demographics, primary tumor site, tumor morphology, stage at diagnosis, first course of treatment, and follow-up vital status.

All patients with primary, histologically confirmed, invasive ESTS were eligible for the study. We restricted eligibility to adults (aged ≥ 18 years) who were diagnosed with ESTS between 1988 and 2003; patients from these years had data available on tumor size and grade. Patients with distant metastases at the time of diagnosis were excluded. Patients were identified by using the *International Classification of Diseases for Oncology, Third Edition* site codes C49.1 and C49.2. Primary bony tumors were excluded. We also excluded patients with Kaposi sarcoma, because the majority of these malignancies occur in patients with acquired immune deficiency syndrome, which may confound determinations of survival. Patients with clear cell sarcoma also were excluded, because this malignancy is more akin to melanoma than

sarcoma. Finally, we excluded patients with known secondary cancers, patients who were identified by death certificate or autopsy, patients with missing cause of death, and a small number of patients who received only intraoperative radiation treatment. The final sample included 6406 patients.

SEER classifies race into 28 mutually exclusive groups by using information from the medical record. Separately, Hispanic ethnicity is determined by using race, Spanish origin, place of birth, and surname. The current study limited analysis to patients in 1 of 4 racial/ethnic groups: non-Hispanic whites (whites), non-Hispanic blacks (blacks), Hispanics, and non-Hispanic Asian/Pacific Islanders (Asians).

Surgery was categorized as either limb-sparing or nonlimb-sparing. Limb-sparing procedures were cancer-directed surgeries that excluded biopsies. Nonlimb-sparing surgeries included upper and lower extremity amputations as well as hindquarter/forequarter amputations and pelvic or shoulder disarticulations. Radiation therapy was categorized as given before surgery, after surgery, both before and after surgery, or not at all. A small number of patients received only intraoperative radiation treatment, and these patients were excluded from subsequent analyses. Patients who received radiation therapy both before and after surgery (N = 95) were considered to have received preoperative therapy.

The date and cause of death were available through database linkage to death certificate data. Using rules developed by SEER, survival time was calculated as the number of completed months between the date of diagnosis and whichever occurred first: the date of death, the date last known to be alive, or December 31, 2004. Patients' date of last known vital status is updated regularly through various follow-up activities, including contacting hospitals and physicians and linking patients' data to administrative databases. The survival endpoint for the current study was death from soft-tissue cancer (SEER cause of death recode = 24,000). Patients who died from other causes, or who were lost to follow-up, or who survived beyond December 31, 2004 were coded as censored observations.

We used *t* tests and chi-square tests to compare patient and tumor characteristics and patterns of treatment among the 4 racial/ethnic groups. After confirming the proportional hazards assumption, we used Cox proportional hazards models to assess the effect of race/ethnicity on survival while adjusting for age and other patient and tumor characteristics. To account for racial differences in competing causes of death, we used the cause-specific survival methodology described by Marubini and Valsecchi.¹⁹

TABLE 1
Racial/Ethnic Differences in Patient and Tumor Characteristics, Adult Extremity Soft Tissue Sarcoma, 1988–2003

Characteristic	White n = 4636	Black n = 663	Hispanic n = 696	Asian n = 411	P
Mean age, y	57.7	51.3	47.9	56.4	<.001
Sex, %					.62
Men	53.2	50.5	52.2	52.6	
Women	46.8	49.5	47.8	47.5	
Tumor size, %					<.001
<5.0 cm	27.9	22.0	27.0	31.4	
≥5.0 cm	49.2	55.7	55.9	52.3	
Unknown	23.0	22.3	17.1	16.3	
Tumor grade, %					.003
Well differentiated	14.2	13.4	16.5	16.8	
Moderately differentiated	18.0	14.8	18.0	17.3	
Poorly differentiated	17.0	13.9	13.0	12.7	
Undifferentiated/anaplastic	20.5	25.6	19.3	19.5	
Unknown	30.6	32.3	33.5	33.8	
Tumor histology, %					.57
Histologies with poorer survival*	1.0	0.9	1.3	1.2	
All other histologies	99.2	99.1	98.7	98.8	

* In a multivariate model that included all histologies, the following tumor types had a 4- to 5-fold increase in the risk of death: undifferentiated sarcoma, leiomyosarcoma, rhabdomyosarcoma, synovial sarcoma, and alveolar soft-part sarcoma.

Using whites as the referent group, we estimated the hazard ratio (HR) and 95% confidence interval (CI) for death from soft-tissue cancer for each of the 3 nonwhite racial/ethnic groups. Using product terms, we tested for and did not observe any statistically significant interactions between race/ethnicity and any of the other patient or tumor characteristics in the models. Patients with missing tumor size or tumor grade were not dropped from the analysis but were assigned a value of “unknown” for these variables. These analyses were conducted by using SAS 9.1.3 for Windows (SAS Institute, Cary, NC).

RESULTS

The characteristics of the study population are shown in Table 1. Eligible patients included 4636 whites, 663 blacks, 696 Hispanics, and 411 Asians. Significant racial and ethnic differences were noted in our patient population with respect to age at diagnosis, tumor size, and tumor grade. No such differences were noted with respect to sex or tumor histology. Overall, Hispanics tended to be diagnosed at a younger age than whites (mean age, 47.9 years vs 57.7 years), blacks (mean age, 51.3 years), and Asians (mean age, 56.4 years). Blacks and Hispanics tended to have fewer tumors that measured <5 cm and more tumors that measured ≥5 cm than either whites or Asians. Hispanics also trended toward higher rates of well-differentiated to moderately dif-

ferentiated ESTS (34.5%) compared with Asians (34.1%), whites (32.2%), and blacks (28.2%). Conversely, blacks were more likely to have poorly differentiated or undifferentiated ESTS (39.5%) compared with their white (37.5%), Hispanic (32.3%), and Asian (32.2%) counterparts. Unfortunately, characteristics like tumor size and tumor grade were not captured for a significant proportion of our study population. Data on tumor size were missing on from 16.3% to 23% of patients, whereas tumor grade data were missing on from 30.6% to 33.8% of patients (Table 1).

For the study population as a whole, 5488 patients (85.7%) underwent limb-sparing procedures. In univariate analysis, Asians had the highest rates of limb-sparing procedures and the lowest rates of amputation (88.8% and 5.1%, respectively) (Table 2). Conversely, blacks had the lowest rates of limb-preserving surgeries and the highest rates of amputations (83% and 10.3%, respectively). Hispanics trended toward lower rates of limb preservation and higher rates of amputation compared with whites. When controlling for age, sex, SEER geographic region, tumor size, tumor grade, and histology, however, only Hispanics had significantly lower rates of limb-sparing surgery compared with whites (odds ratio [OR], 0.76; 95% CI, 0.59–0.97) (Table 2). Although there was a trend toward lower rates of limb preservation in blacks, this was not statistically significant (OR, 0.86; 95% CI, 0.68–1.09). The rates of

TABLE 2
Racial/Ethnic Differences in Limb-Preserving Surgery for Adult Extremity Soft Tissue Sarcoma, 1988–2003,
Univariate Analysis (Top) and Multivariate Analysis Adjusting for Age, Sex, SEER Geographic Region,
Tumor Size, Tumor Grade, and Histology (Bottom)

Surgical treatment	White n = 4636	Black n = 663	Hispanic n = 696	Asian n = 411
	Proportion receiving treatment, %			
Excision, resection, or other limb-sparing surgery	86.0	83.0	84.2	88.8
Amputation	7.6	10.3	9.5	5.1
No cancer-directed surgery	6.4	6.8	6.3	6.1
	Multivariate OR for receiving treatment (95% CI)			
Excision, resection, or other limb-sparing surgery	1.00 (Referent)	0.86 (0.68–1.09)	0.76 (0.59–0.97)	1.21 (0.83–1.77)

OR indicates odds ratio; CI, confidence interval.

TABLE 3
Racial/Ethnic Differences in First Course of Treatment, Adult Extremity Soft-Tissue Sarcoma, 1988–2003,
Univariate Analysis (Top) and Multivariate Analysis Controlling for Age, Sex, SEER Geographic Region,
Tumor Size, Tumor Grade, and Histology (Bottom)

First course of treatment	White n = 4636	Black n = 663	Hispanic n = 696	Asian n = 411
	Proportion receiving treatment, %			
Surgery alone	46.3	53.7	49.0	45.3
Radiation alone	1.9	2.9	1.3	1.5
Neither surgery nor radiation	4.5	3.9	5.0	4.6
Both surgery and radiation	47.3	39.5	44.7	48.7
Radiation before surgery	6.3	8.1	6.2	6.6
Radiation after surgery	38.4	31.2	37.8	41.4
Intraoperative radiation with other radiation given before or after surgery	0.7	0.0	0.1	0.2
Sequence unknown, but both surgery and radiation were given	1.9	0.2	0.6	0.5
	Multivariate OR for receiving treatment (95% CI)			
Both surgery and radiation	1.00 (referent)	0.77 (0.66–0.90)	0.88 (0.73–1.06)	1.01 (0.79–1.29)

OR indicates odds ratio; CI, confidence interval.

limb preservation among Asians did not differ significantly from the rates among whites (OR, 1.21; 95% CI, 0.83–1.77).

For the study population as a whole, radiation therapy was received in conjunction with surgery in 2966 patients (46.3%) (Table 3). Most patients received their radiation postoperatively (37.8%). Only a small proportion of patients received radiation preoperatively (6%). In univariate analysis, blacks had the lowest rates of radiation therapy used in conjunction with surgery (39.5%), whereas the highest rates were reported in Asians (48.7%). Blacks had the lowest rate of postoperative radiation therapy (31.2%) but the highest rate of preoperative radiation therapy (8.1%). Asians had the highest rate of postoperative radiation therapy (41.4%), and Hispanics had the lowest (37.8%). In a multivariate analysis controlling for patient age, sex, SEER geographic region, extent of tumor, tumor size, grade, and histology, blacks

were 23% less likely than whites to receive both surgical and radiation therapy for their ESTS (OR, 0.77; 95% CI, 0.66–0.90) (Table 3).

The 5-year risk of death from ESTS was highest for blacks (18.4%), followed by whites (13.6%) and Hispanics (11.7%), and Asians had the lowest 5-year risk of death (9.4%) (Table 4). In a multivariate analysis controlling for patient age, sex, SEER geographic location, tumor size, tumor grade, and tumor histology, only blacks had significantly lower rates of disease-specific survival (Fig. 1) (Table 4). Blacks demonstrated a 39% relative increase in risk of sarcoma-related death (HR, 1.39; 95% CI, 1.13–1.70). In contrast, Asians were 33% less likely than whites to experience a sarcoma-related death (HR, 0.67; 95% CI, 0.46–0.97).

DISCUSSION

In the 2000 United States census, roughly 30% of the population identified themselves as racial or ethnic

TABLE 4
Racial/Ethnic Differences in Disease-Specific Survival in Adult Patients With Extremity Soft-Tissue Sarcoma, 1988–2003

Racial/ethnic group	Cases	Deaths from cancer within 5 years	5-year risk of death from cancer, %*	Multivariate HR for death from cancer (95% CI)*
White	4636	707	13.6	1.00 (referent)
Black	663	121	18.4	1.39 (1.13–1.70)
Hispanic	696	74	11.7	0.85 (0.66–1.10)
Asian	411	40	9.4	0.67 (0.46–0.97)

HR indicates hazard ratio; CI, confidence interval.

* From a Cox proportional hazards model that adjusted for age, sex, Surveillance, Epidemiology, and Ends Results geographic region, tumor size, tumor grade, and tumor histology.

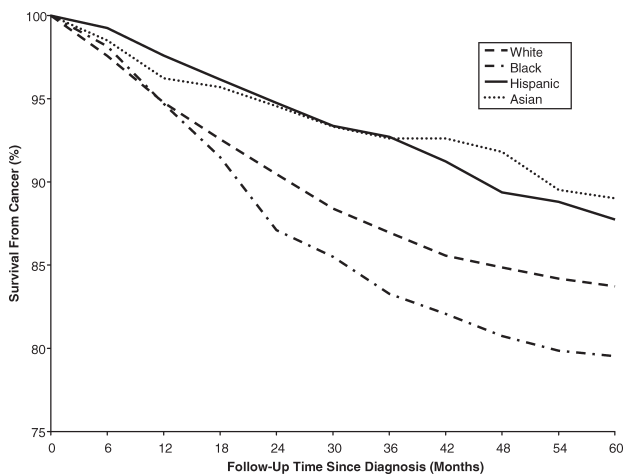


FIGURE 1. Racial/ethnic differences in disease-specific survival among adult patients with extremity soft tissue sarcoma.

minorities; by 2050, it is projected that the number will approach 50%.²⁰ The Agency for Healthcare Research and Quality issued the *National Healthcare Disparities Report* in 2005 and identified several barriers to quality healthcare encountered by minority populations. Blacks, Hispanics, and Asians had worse access to care for 43% to 87% of indicators and received poorer quality of care for 21% to 50% of indicators relative to whites.²⁰ Simply put, racial and ethnic disparities in healthcare delivery exist. The reasons for these disparities are unknown, as noted in our study, but are likely multifactorial.^{21,22}

Our study demonstrated that significant racial and ethnic differences exist with regard to patient and tumor characteristics, treatment provided for ESTS, and ESTS-specific survival. Hispanics tended to be diagnosed with ESTS at a younger age than their white, black, and Asian counterparts, which may suggest either a biologic predisposition or an environmental contributing factor for the development of these tumors.²³ Blacks, Hispanics, and

Asians tended to have larger tumors than whites and a higher proportion of ESTS that measured ≥ 5 cm. We do not know why these patients present with more advanced tumors; however, poorer access to healthcare may be a contributing factor. It is also possible that these patients may have had a delay in diagnosis because of their treating physicians' lack of understanding of the underlying disease process.

Only Hispanics had significantly lower rates of limb-preserving surgery and, thus, were more likely to undergo an amputation for their ESTS. We initially believed that this discrepancy was because Hispanics tended to present with larger primary tumors. Even controlling for this, however, Hispanics received 24% less limb-preserving surgeries than their white counterparts. Barriers to healthcare access also may play a role here. Hispanic patients may be less likely to be seen at cancer centers or major medical centers with expertise in ESTS care.²⁴ Hispanics had the lowest rate of preoperative radiation therapy in univariate analysis, which partially may explain this result, because preoperative radiation therapy can be used to make limb preservation more practical in patients who otherwise would require amputation.

Overall, the rate of patients receiving radiation therapy in addition to surgery was lower than expected. Some clinicians may have a bias against treating smaller, lower grade ESTS with radiation. Geer et al documented no improvement in local recurrence rates among patients with ESTS < 5 cm who underwent surgical resection and received radiation therapy compared with patients who underwent complete surgical resection alone.²⁵ Even accounting for this potential bias, the rates of radiation therapy were low in our population of patients. Only 46.8% of all patients received radiotherapy, whereas 50.8% had tumors ≥ 5 cm. Black and Hispanic patients were more likely to have large tumors (55.7% and 55.9%, respectively) and were less likely to have received

radiation therapy in addition to surgery (39.5% and 44.7%, respectively). Only blacks, however, received significantly less radiation therapy with surgery than whites in a multivariate analysis. The reasons for this are not clear but may include patient preference, poor patient compliance, less access to cancer centers or medical centers with experience in the treatment of ESTS, or variant biologic behavior that precludes limb preservation with or without radiation therapy.

Blacks, who, in general, had poorer tumor characteristics and received less radiation in conjunction with surgery, demonstrated a disease-specific death rate that was 39% higher than that of their white counterparts, even when controlling for several factors known to influence sarcoma-specific survival.²⁶ Differences in disease-specific survival are not necessarily expected given disparities in treatment, because randomized clinical data indicate no significant survival differences in patients who undergo limb preservation as opposed to amputation.⁶⁻⁸ Treatment differences in the rates of radiation therapy or limb preservation may be attributable to healthcare access barriers, such as the lack of cancer-specific physician expertise, the lack of or poor quality insurance, low patient socioeconomic status, language barriers, or unavailability of reliable transportation. Obesity, diabetes, and hypertension are more prevalent in the black and Hispanic populations compared with the Asian population.²⁷ Although these comorbidities may not contribute directly to ESTS-specific mortality, they may do so indirectly, by making these populations less able to respond to the burden of disease. This explanation is tempered, however, by the unexpectedly low disease-specific mortality rates observed among Hispanics in our study. Hispanics, although they are subject to several of the same socioeconomic factors and exhibit several of the same poor tumor prognostic factors and comorbidities as blacks, displayed a disease-specific survival that, although not significantly superior to whites, clearly trended in that direction (Fig. 1). Information regarding racial and ethnicity-specific molecular changes within ESTS is virtually unknown. A variety of genetic alterations, such as microsatellite instability, allelic loss, mutation, gene amplification, and tumor suppressor silencing by promoter region hypermethylation, need to be studied more adequately in these populations to determine whether underlying biologic differences are responsible for the differences in tumor characteristics and behavior observed in the current study.

Regardless of race/ethnicity, approximately 6% of patients did not undergo cancer-directed surgery for their ESTS. This likely reflects the reality of our popula-

tion-based data. Unlike single institution-based studies, which are subject to referral bias, whereby nearly all patients are treated because they have actively sought out or have been referred to that center, our study represents what is occurring at all levels of healthcare, from academic university health centers to rural community hospitals, and may be more generalizable.

Our study was not without limitations. Our patient population was limited because we excluded cases of ESTS before 1988. Although several significant studies on the role of adjuvant radiation therapy in patients who were eligible for limb-preservation were not published until the 1990s,^{6,8,28,29} enough evidence was available by the 1980s^{30,31} for the National Institutes of Health to issue a consensus statement on the role of radiation therapy in limb preservation for patients with ESTS.³ Therefore, we chose to limit the period of our study to the more modern era of ESTS surgery incorporating limb preservation, from 1988 to 2003. Furthermore, Although we have good information regarding the type of treatment patients received (surgery, radiation, or both), we do not have data on the appropriateness or adequacy of that treatment for individual patients. Given our sample size, it is unlikely that such deficiencies played a significant role in our results, particularly because very few patients require an amputation to achieve negative margins.⁵ Some researchers suggest that socioeconomic status is more predictive of treatment quality received than race or ethnicity.³² Unfortunately, our current analysis did not afford us the opportunity to assess individual patients' socioeconomic status. In addition, we have no information regarding whether or not patients received chemotherapy. Data on whether adjuvant chemotherapy improves survival in patients with ESTS are conflicting.³³⁻³⁵ Therefore, it is unlikely that the use of or the failure to use systemic chemotherapy was responsible for any of the survival differences observed in our study. We attempted to control for potential confounding factors that could influence our ability to detect differences between racial or ethnic groups, but this admittedly is hard to do. Race/ethnicity is likely just one factor interacting with many others to influence patient treatment and outcome.³⁶

In conclusion, racial and ethnic disparities in both ESTS treatment and outcomes were not explained by differences in the patient or tumor characteristics we examined. Although identifying causes for these disparities was beyond the scope of this study, we believe that these differences probably are multifactorial. The identification of racial/ethnic differences should serve to focus our efforts toward improving ESTS treatment and outcomes for all patients, especially those most at risk.

REFERENCES

- American Cancer Society. Cancer Facts and Figures 2007. Atlanta, Ga: American Cancer Society; 2007.
- Brennan M, Singer S, Maki RG, et al. Sarcomas of the soft tissues and bone. In: DeVita VT Jr, Hellman S, Rosenberg SA, eds. Cancer: Principles and Practice of Oncology, 7th ed. Philadelphia, PA: Lippincott Williams & Wilkins; 2005.
- Consensus Conference. Limb-sparing treatment of adult soft-tissue sarcomas and osteosarcomas. *JAMA*. 1985;254:1791-1794.
- Pisters PW, O'Sullivan B, Maki RG. Evidence-based recommendations for local therapy for soft tissue sarcomas. *J Clin Oncol*. 2007;25:1003-1008.
- Brennan MF, Casper ES, Harrison LB, Shiu MH, Gaynor J, Hajdu SI. The role of multimodality therapy in soft-tissue sarcoma. *Ann Surg*. 1991;214:328-336; discussion 336-338.
- Yang JC, Chang AE, Baker AR, et al. Randomized prospective study of the benefit of adjuvant radiation therapy in the treatment of soft tissue sarcomas of the extremity. *J Clin Oncol*. 1998;16:197-203.
- O'Sullivan B, Davis AM, Turcotte R, et al. Preoperative versus postoperative radiotherapy in soft-tissue sarcoma of the limbs: a randomised trial. *Lancet*. 2002;359:2235-2241.
- Pisters PW, Harrison LB, Leung DH, Woodruff JM, Casper ES, Brennan MF. Long-term results of a prospective randomized trial of adjuvant brachytherapy in soft tissue sarcoma. *J Clin Oncol*. 1996;14:859-868.
- Mack TM. Sarcomas and other malignancies of soft tissue, retroperitoneum, peritoneum, pleura, heart, mediastinum, and spleen. *Cancer*. 1995;75(1 suppl):211-244.
- Meric F, Hess KR, Varma DG, et al. Radiographic response to neoadjuvant chemotherapy is a predictor of local control and survival in soft tissue sarcomas. *Cancer*. 2002;95:1120-1126.
- Temple CL, Ross DC, Magi E, DiFrancesco LM, Kurien E, Temple WJ. Preoperative chemoradiation and flap reconstruction provide high local control and low wound complication rates for patients undergoing limb salvage surgery for upper extremity tumors. *J Surg Oncol*. 2007;95:135-141.
- Briggs NC, Levine RS, Hall HI, Cosby O, Brann EA, Hennekens CH. Occupational risk factors for selected cancers among African American and white men in the United States. *Am J Public Health*. 2003;93:1748-1752.
- Brooks SE, Zhan M, Cote T, Baquet CR. Surveillance, Epidemiology, and End Results analysis of 2677 cases of uterine sarcoma 1989-1999. *Gynecol Oncol*. 2004;93:204-208.
- Devesa SS, Blot WJ, Stone BJ, Miller BA, Tarone RE, Fraumeni JF Jr. Recent cancer trends in the United States. *J Natl Cancer Inst*. 1995;87:175-182.
- Martinez SR, Chen SL, Bilchik AJ. Treatment disparities in Hispanic rectal cancer patients: a SEER database study. *Am Surg*. 2006;72:906-908.
- O'Connell JB, Maggard MA, Ko CY. Cancer-directed surgery for localized disease: decreased use in the elderly. *Ann Surg Oncol*. 2004;11:962-969.
- Sherman ME, Devesa SS. Analysis of racial differences in incidence, survival, and mortality for malignant tumors of the uterine corpus. *Cancer*. 2003;98:176-186.
- Alderman AK, Kim HM, Kotsis SV, Chung KC. Upper-extremity sarcomas in the United States: analysis of the surveillance, epidemiology, and end results database, 1973-1998. *J Hand Surg [Am]*. 2003;28:511-518.
- Marubini E, Valsecchi MG. Analysing Survival Data from Clinical Trials and Observational Studies. Chichester, England: John Wiley & Sons; 1995.
- Racial and Ethnic Minorities. National Healthcare Disparities Report, 2005. Rockville, MD: US Department of Health and Human Services, Agency for Healthcare Research and Quality; 2005:119-130.
- Gansler T, Henley SJ, Stein K, Nehl EJ, Smigal C, Slaughter E. Sociodemographic determinants of cancer treatment health literacy. *Cancer*. 2005;104:653-660.
- Potosky AL, Harlan LC, Kaplan RS, Johnson KA, Lynch CF. Age, sex, and racial differences in the use of standard adjuvant therapy for colorectal cancer. *J Clin Oncol*. 2002;20:1192-1202.
- Zahm SH, Fraumeni JF Jr. The epidemiology of soft tissue sarcoma. *Semin Oncol*. 1997;24:504-514.
- Liu JH, Zingmond DS, McGory ML, et al. Disparities in the utilization of high-volume hospitals for complex surgery. *JAMA*. 2006;296:1973-1980.
- Geer RJ, Woodruff J, Casper ES, Brennan MF. Management of small soft-tissue sarcoma of the extremity in adults. *Arch Surg*. 1992;127:1285-1289.
- Kattan MW, Leung DH, Brennan MF. Postoperative nomogram for 12-year sarcoma-specific death. *J Clin Oncol*. 2002;20:791-796.
- Smith SC Jr, Clark LT, Cooper RS, et al. Discovering the full spectrum of cardiovascular disease: Minority Health Summit 2003: report of the Obesity, Metabolic Syndrome, and Hypertension Writing Group. *Circulation*. 2005;111:e134-e139.
- Suit HD, Spiro I. Role of radiation in the management of adult patients with sarcoma of soft tissue. *Semin Surg Oncol*. 1994;10:347-356.
- Wilson AN, Davis A, Bell RS, et al. Local control of soft tissue sarcoma of the extremity: the experience of a multidisciplinary sarcoma group with definitive surgery and radiotherapy. *Eur J Cancer*. 1994;30A:746-751.
- Barkley HT Jr, Martin RG, Romsdahl MM, Lindberg R, Zagars GK. Treatment of soft tissue sarcomas by preoperative irradiation and conservative surgical resection. *Int J Radiat Oncol Biol Phys*. 1988;14:693-699.
- Rosenberg SA, Tepper J, Glatstein E. The treatment of soft-tissue sarcomas of the extremities: prospective randomized evaluations of limb-sparing surgery plus radiation therapy compared with amputation and the role of adjuvant chemotherapy. *Ann Surg*. 1982;196:305-315.
- McGory ML, Zingmond DS, Sekeris E, Bastani R, Ko CY. A patient's race/ethnicity does not explain the underuse of appropriate adjuvant therapy in colorectal cancer. *Dis Colon Rectum*. 2006;49:319-329.
- [No authors listed] Adjuvant chemotherapy for localised resectable soft-tissue sarcoma of adults: meta-analysis of individual data. Sarcoma Meta-analysis Collaboration. *Lancet*. 1997;350:1647-1654.
- Frustaci S, Gherlinzoni F, De Paoli A, et al. Adjuvant chemotherapy for adult soft tissue sarcomas of the extremities and girdles: results of the Italian randomized cooperative trial. *J Clin Oncol*. 2001;19:1238-1247.
- Tierney JF, Mosseri V, Stewart LA, Souhami RL, Parmar MK. Adjuvant chemotherapy for soft-tissue sarcoma: review and meta-analysis of the published results of randomised clinical trials. *Br J Cancer*. 1995;72:469-475.
- Asch DA, Armstrong K. Aggregating and partitioning populations in health care disparities research: differences in perspective. *J Clin Oncol*. 2007;25:2117-2121.



Racial and Ethnic Differences in Treatment and Survival Among Adults With Primary Extremity Soft-Tissue Sarcoma

Steve R. Martinez, Anthony S. Robbins, Frederick J. Meyers, Richard J. Bold, Vijay P. Khatri, and James E. Goodnight, Jr.

The results from this study indicated that there are significant racial/ethnic differences in treatment and survival among adults with extremity soft tissue sarcoma. Compared with whites, survival was poorer for blacks but better for Asians.