Published in final edited form as:

Pediatr Blood Cancer. 2015 March ; 62(3): 456–462. doi:10.1002/pbc.25326.

Comparison of Survival at Adult versus Pediatric Treatment Centers for Rare Pediatric Tumors in an Adolescent and Young Adult (AYA) Population in the State of Georgia

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Abstract

Background—The type of treatment center where 15-21-year-old adolescent and young adult (AYA) patients with rare pediatric tumors achieve their best clinical outcome is unknown.

Procedure—We performed a retrospective analysis using the Georgia Cancer Registry (GCR) of 15-21-year-old patients with a malignant, rare pediatric tumor diagnosed during the period from 2000-2009. Patients were identified as being treated at one of five Georgia pediatric cancer centers or at an adult center. Data were analyzed for 10-year overall survival, patient characteristics associated with death, and patient characteristics present at diagnosis associated with choice of treatment center.

Results—There was a total of 479 patients in our final study population, of which 379 (79.1%) were treated at an adult center and 100 (20.9%) were treated at a pediatric center. Patients treated at an adult center had a 10-year overall survival of 86% compared to 85% for patients treated at a pediatric center ($p=0.31$). Race and poverty were not significantly associated with death. Patients with nasopharyngeal carcinoma (OR=7.38; 95% CI=2.30 – 23.75) and ‘other carcinomas’ (OR=2.64; 95% CI=1.25 – 5.60) were more likely to be treated at a pediatric center. Patients with higher-stage disease (OR=4.24; 95% CI=1.71 – 10.52) and higher poverty (OR=2.32; 95% CI=1.23 – 4.37) were also more likely to be treated at a pediatric center.

Conclusion—Our data suggest that there is no difference in survival for 15-21-year-old patients with rare pediatric tumors when treated at an adult or pediatric center.

Keywords

Adolescent and young adult oncology; rare pediatric tumors; carcinoma; melanoma; cancer outcomes; survival comparison

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Conflict of Interest Statement

None of the authors of this manuscript have any conflicts of interest to report.

INTRODUCTION

Over the last three decades adolescent and young adult (AYA) patients with cancer have not experienced the same improvement in survival as that seen in younger or older patients. During the same time period the incidence of cancer increased more rapidly for AYA patients than any other age group [1]. Part of the challenge in treating AYA patients is deciding where they should be treated for their malignancy. This is difficult for the entire 15-29-year-old AYA population, but becomes even more challenging for the subset of AYA patients that are 15-21 years of age, because they could be treated at either a pediatric or adult center. The discrepancy in survival, often referred to as the AYA Gap, has also occurred in part due to the lack of recognition that this population requires focused attention to the unique biology of its malignancies and to its psychosocial and supportive care needs [2,3]. Due to the lack of survival improvement for this population of patients, it is critical to better understand where they can achieve their optimal clinical outcomes in order to maximize treatment strategies.

In pediatric oncology, much of the improvement in survival has come as a result of patients being treated on cooperative group clinical trials. Furthermore, it has been observed that the single factor most highly correlated with the AYA Gap is lack of participation in clinical trials [4]. Historically, more than 90% of patients younger than 15 years are treated at institutions that participate in NCI-sponsored clinical trials with 70-80% of patients being treated on an open study [4]. In contrast, only 20% of patients who are 15-19 years of age are treated at such institutions, and only 10% of patients in this age group participate in clinical trials [5]. The numbers are even lower among 20-29-year-olds, where only 10% are treated at institutions that are members of either adult or pediatric cooperative groups, and only 1% participates in cooperative group trials [5]. Poor enrollment on clinical trials is even more noticeable among AYA patients with a rare pediatric tumor histology, such as carcinoma or melanoma [6,7].

The factors that determine if an AYA patient with a rare tumor is treated at a pediatric or adult facility have never been adequately described in an objective manner. Because of the paucity of information available on the lack of improvement in survival, the focus of these analyses is on the diagnosis of rare tumors within this younger AYA population. The objectives of this study were to 1) identify the patient characteristics present at diagnosis that influence whether 15-21-year-old patients with rare pediatric tumors receive treatment at an adult or pediatric center, 2) determine the effect of the treatment center (adult vs. pediatric) on therapy received for 15-21-year-old patients with rare pediatric tumors, and 3) determine the effect of the treatment center (adult vs. pediatric) on survival for 15-21-year-old patients with rare pediatric tumors.

METHODS

This is a retrospective cohort study performed with data collected from the Georgia Cancer Registry (GCR). The GCR is a statewide population-based cancer registry charged with collecting all cancer cases diagnosed among Georgia residents since January 1, 1995. The registry participates in both the Center for Disease Control and Prevention's National

Program of Cancer Registries (NPCR) and the National Cancer Institute's Surveillance, Epidemiology and End Results (SEER) Program and has a reported incidence capture rate of 98% [8].

Patients included in the study were between 15-21 years of age when diagnosed with a malignant, rare pediatric tumor during the period from 2000-2009. Because 15-21-year-old patients would be eligible for treatment at either an adult or pediatric facility, we chose to limit our study to only this subset of the AYA population. For our analysis we further divided patients into a young (15-18 years) and old (19-21 years) age group. Defining rare tumors in pediatrics is difficult considering that pediatric cancer itself is rare with only 12,400 new cases diagnosed yearly in the United States in patients under the age of 20 [9]. We defined rare pediatric tumors as those malignancies classified as 'Other Malignant Epithelial Neoplasms and Melanomas' in the International Classification of Childhood Cancer (ICCC) Subgroup XI [10]. The data collected from the GCR included sex, race, ethnicity, age at diagnosis, tumor histology, grade, stage, primary site, diagnosis year, type of treatment (radiation, surgery, chemotherapy, combined, or none), treatment center (adult vs. pediatric), distance to the closest pediatric center, poverty status, date of last contact, and survival status.

Patients were divided into four diagnosis groups including melanoma, thyroid carcinoma, nasopharyngeal carcinoma, and other carcinomas. The 'other carcinomas' group was comprised of 46 different subtypes and included carcinomas of the colon (N=16), lung (N=14), cervix (N=14), breast (N=12), parotid gland (N=10), ovary (N=8), and kidney (N=6). The primary site data collected from the GCR was collapsed into the organ system-based primary site locations of head and neck, gastrointestinal (GI), lung, skin, genitourinary (GU), thyroid, and other. Patients diagnosed or ever treated at one of the five pediatric centers in Georgia were designated by the GCR as being treated at a pediatric center while all others were designated as being treated at an adult center.

Socioeconomic status was assessed by obtaining information about economic poverty. Patients in the GCR are geocoded to the census tract level based on their address at the time of diagnosis. Each patient is then linked by their census tract to 2000 U.S. Census data to determine the percentage of individuals in the tract living below the federal poverty line. Patients are next grouped into one of four categories: those living in a census tract where 1) < 5%, 2) 5% but < 10%, 3) 10 but < 20%, or 4) 20% of the population in that tract was living below the federal poverty line. An area where 20% of the population live below the federal poverty line is considered a federal poverty area [11]. Using these grouped area-based measures of socioeconomic status provided by the GCR, we then categorized the patients in our study into a low poverty group (groups 1-3 above) and a high poverty group (group 4 above).

The effect of distance on treatment center selected was examined by calculating the distance that each patient lived from the closest pediatric center. The distance to all five centers was calculated for each patient using latitude and longitude coordinates. We then selected the distance to the closest pediatric center for each patient and used this distance in our analysis as the GCR does not release identifiable facility-specific data to investigators. For patients

who were actually treated at a pediatric center, this was not necessarily the actual pediatric center where they received treatment. We categorized the distance needed to travel to the closest pediatric center into three groups: 1) ≤ 25 miles, 2) > 25 but ≤ 50 miles, and 3) > 50 miles.

The distribution of patient characteristics present at diagnosis was compared for patients treated at an adult or pediatric center using a chi-square or Fisher's exact test for categorical variables and a 2-sample t-test for continuous variables. Multivariate logistic regression was performed to identify patient characteristics present at diagnosis that were associated with treatment center. Decisions on what variables to include in the model were made based on considerations of the univariate analysis and clinical relevance and included age, stage, race, diagnosis, poverty status, and distance from the closest pediatric center. Additionally, patients were divided by diagnosis and comparisons were made by using a chi-square or Fisher's exact test to determine how their treatments differed by treatment center (adult vs. pediatric).

A Kaplan-Meier analysis was performed to compare 10-year overall survival by treatment center and a multivariate survival analysis was performed using a Cox proportional hazards model to determine the association between 10-year overall survival and treatment center, while controlling for other covariates. A similar modeling strategy to that used in the multivariate logistic regression was used for the Cox model, and included the same variables with the addition of treatment facility. Since we wanted to assess the effect of treatment, we did not control for this in our Cox model. Survival times were measured from the day of diagnosis to the day of death from any cause.

This study was approved by the institutional review board (IRB) at the Georgia Department of Public Health and Emory University. A Health Insurance Portability and Accountability Act (HIPAA) waiver was obtained from the IRB.

RESULTS

There were 479 patients diagnosed between the ages of 15-21 with a malignant, rare pediatric tumor in the state of Georgia from 2000-2009. There were 171 (35.7%) melanomas, 157 (32.8%) thyroid carcinomas, 25 (5.2%) nasopharyngeal carcinomas, and 126 (26.3%) other carcinomas. Average follow-up time for the entire cohort was 5.3 years.

A comparison of patient characteristics by treatment center is shown in Table I. There were 379 (79.1%) patients treated at an adult center and 100 patients (20.9%) treated at a pediatric center. The mean age for patients treated at adult centers was 18.9 years compared to 17.5 years for pediatric centers ($p < 0.01$), and accordingly, a higher percentage of patients treated at adult centers were in the older age group (63.6%), whereas a higher percentage of patients treated at pediatric centers were in the younger age group (68.0%) ($p < 0.01$). Non-Hispanic white patients constituted a larger percentage of those treated at adult centers (75.5% vs. 65.0%), while black patients constituted a larger percentage of those treated at pediatric centers (30.0% vs. 14.8%) ($p = 0.01$). A higher percentage of regional (34.0% vs. 25.3%) and distant (17.0% vs. 4.0%) stage patients were treated at pediatric centers relative

to adult centers ($p < 0.01$). There was a higher proportion of patients treated at pediatric centers who had distant stage disease for nasopharyngeal carcinoma (NPC) (28.6% vs. 9.1%, $p=0.03$) and other carcinomas (27.3% vs. 9.7%, $p=0.04$), but not for thyroid carcinoma (11.8% vs. 4.1%, $p=0.20$). There were no patients in the study with melanoma who had distant stage disease, but 36.8% of those with melanoma treated at pediatric centers had regional stage compared to 14.5% of those treated at an adult center ($p=0.06$).

There were no significant differences between treatment center groups for poverty status or distance to the closest pediatric center. Factors that were significantly associated with treatment at a pediatric center in our multivariate analysis included age, diagnosis, stage, and poverty (Table II). Patients in the older age group were less likely to be treated at a pediatric center compared to patients in the younger age group [odds ratio (OR) = 0.22 (95% confidence interval (CI) = 0.13 – 0.37)]. Patients with both nasopharyngeal carcinoma and one of the other carcinomas were more likely to be treated at a pediatric center than those with melanoma, but patients with thyroid carcinoma were not. Patients with distant stage disease were more likely to be treated at a pediatric center compared to patients with local stage disease [OR = 4.24 (95% CI = 1.710 – 10.520)]. Distance to the closest pediatric center did not influence which type of treatment center was chosen. In contrast to our univariate analysis shown in Table 1, race did not show a significant association to be being treated at a pediatric center, but poverty status did. Specifically, those in the high poverty group had an OR of 2.32 (95% CI = 1.23 – 4.37) compared to those in the low poverty group.

Treatments differed by center for thyroid and NPC, but not for melanomas and other carcinomas (Table III). An equal proportion of patients with thyroid carcinoma received surgery at both adult (96.8%) and pediatric (97.1%) centers ($p=1.00$), but a significantly higher proportion of patients received radiation (82.4% vs. 61.0%, $p=0.02$) and combined therapy (82.4% vs. 61.0%, $p=0.02$) at pediatric centers. All 14 (100.0%) patients with NPC treated at pediatric centers received chemotherapy compared to only (63.6%) at adult centers ($p=0.03$). Additionally, 54.6% of patients with NPC treated at adult centers received surgery compared to only 14.3% of those treated at pediatric centers ($p=0.08$).

There was no difference in 10-year overall survival (OS) for patients treated at adult (86%) versus pediatric (85%) centers (log rank p -value= 0.31) (Figure 1). Factors significantly associated with death included diagnosis and stage, but not treatment center, age, race, distance to the closest pediatric center, or poverty (Table IV). For diagnosis, patients with thyroid carcinoma had a hazard ratio (HR) for death of 0.05 (95% CI= 0.01 – 0.41) compared to those with melanoma. Patients with both regional [HR = 4.66 (95% CI = 2.07 – 10.52)] and distant [HR = 20.97 (95% CI = 7.73 – 56.89)] stage had an increased HR compared to those with local stage disease ($p < 0.01$). The HR for pediatric treatment center compared to those treated at an adult center was 0.83 (95% CI = 0.36 – 1.92).

Subgroup analysis comparing 10-year OS by treatment facility for each of the four diagnosis groups failed to reveal any meaningful results. The only significant differences seen were among patients with thyroid carcinoma, where those treated at an adult facility had a higher

10-year OS (100% vs. 93%; $p=0.02$). However, there was only one event among all 157 thyroid carcinoma patients limiting the conclusions that can be drawn from this analysis.

DISCUSSION

The results of our study suggest that treatment center (adult or pediatric) does not impact survival for 15-21-year-old patients with rare pediatric tumors since the 10-year overall survival was almost identical for both center types. This is particularly interesting considering there were a significantly higher proportion of patients with regional and distant stage disease treated at pediatric centers. When stage was controlled for in our multivariate analysis, treatment facility still did not impact survival.

In contrast to the results of our study, previous studies have shown that AYA patients with malignancies seen more commonly in pediatric populations have better treatment outcomes when treated at pediatric centers on pediatric treatment protocols [12-14]. Howell et al. showed a trend for better survival for 15-19-year-old patients with carcinoma and melanoma in the state of Georgia when treated at adult centers leading these authors to hypothesize that patients with these malignancies seen more commonly in adults might have better outcomes when treated at adult centers [15]. Almost 80% of the patients in our study were treated at adult centers. This is higher than previous reports showing that about 2/3 of all 15-19-year-old oncology patients are treated at adult centers [15-16].

Patient characteristics that were associated with survival include diagnosis and stage of disease. Specifically, higher stage was associated with death, while having thyroid carcinoma was associated with better survival when compared to patients with melanoma. Notably race and poverty were not associated with worse outcomes in our study. This is in contrast to previous reports that show worse outcomes for most pediatric cancers in patients who are black or Hispanic, and those with lower socioeconomic status (SES) [17-20].

In our multivariate analysis, age, stage, diagnosis, and poverty status were the factors present at diagnosis that influenced treatment center. Patients in the older age group were more likely to be treated at an adult center while patients with higher-stage disease were more likely to be treated at a pediatric center. This is consistent with what has been reported in the literature [15]. Contrary to what we hypothesized, distance to a pediatric treatment center did not significantly influence treatment center, but poverty did. Patients in the high poverty group were significantly more likely to be treated at a pediatric center, suggesting that the referral pattern for these patients may be influenced by insurance status. No interaction was found between distance and poverty, suggesting that patients with high poverty were more likely to be treated at pediatric centers regardless of distance needed to travel.

The patients were stratified by diagnosis and then were analyzed by the treatment they received at their respective treatment center. Two major factors were seen consistently in this comparison among patients with thyroid and nasopharyngeal carcinomas. First, a higher proportion of patients treated at pediatric centers received more aggressive therapy, i.e., combination therapy to obtain disease control. Second, for patients with nasopharyngeal

carcinoma there was some suggestion that those treated at adult centers were more likely to receive surgery as part of their treatment. This may be due to adult surgeons being willing to perform a more radical surgery or pediatric surgeons appropriately avoiding a radical surgical approach in a patient with widely metastatic disease.

A review of the National Comprehensive Cancer Network (NCCN) guidelines shows there are generally multiple options for treatment for any given stage or diagnosis of an adult carcinoma, and while there are Category 1 recommendations, many of the treatments are based on expert consensus (Category 2A or B) rather than controlled trials. Randomized trials for NPC and thyroid cancer have been conducted, but are few, and only found in adult populations. For thyroid cancer, treatment protocols are mostly based on consensus statements, and while there are various ways to manage the disease, there is little long term data to guide care even after five decades of successful treatment. Central node compartment dissection, lateral neck dissection, dose of ablative iodine, and even target TSH goals following treatment are still not defined. In the absence of clear guidelines, collaboration with more experienced providers is essential.

Our study comprises a large sample size of rare pediatric tumors in a subset of the AYA population, and features a comprehensive list of rare pediatric tumor diagnoses instead of a single rare histology. The Georgia Cancer Registry has been recognized for its quality and completeness as evidenced by its recent inclusion into the SEER Program in 2010 with diagnosis year data back to 2000, and as such provided a reliable database to perform our study. By using the GCR we were able to identify the type of treatment center (adult vs. pediatric) for each individual patient, and to perform meaningful analysis based on this information. Another strength of this study was the information obtained about poverty status. Studies have shown that poverty status is the most robust area-based measure to detect socioeconomic inequalities in cancer incidence and mortality, and the census tract has been shown to provide more homogenous and accurate groupings than other area-based measures [21]. The ability to link each patient's geocode to the 2000 census data provided a representation of each individual's overall socioeconomic status as it relates to the neighborhood in which they live. Distance has been proposed in many studies as a barrier to receiving treatment at specialized centers, including pediatric oncology centers. Our study is the first to measure this in an objective way for AYA patients.

This study has a number of limitations that could affect our data. First, we were not able to pinpoint the exact pediatric treatment center for those patients who were treated at a pediatric facility. Since the GCR does not release identifiable facility-specific data, we made the assumption that the pediatric center closest to the patient was the likely treating center. Second, we assumed that those patients who were designated as treated at a pediatric center were actually treated by a pediatric oncologist, which should have been the case. Third, patients may also have been treated outside of Georgia, and therefore may have been missed; however, given the regularly scheduled data-sharing agreements between state cancer registries, the effect of this bias is thought to be very small. Fourth, observational studies are susceptible to unmeasured confounders. There is data to show that there is underreporting for some patient diagnoses as well as treatment in population-based cancer registries, and this could have affected the accuracy of our data [22-23]. Finally, we were

limited by the lack of specific treatment details available in the GCR, such as the chemotherapeutic agent, dose, and schedule used.

In conclusion, focused research on all cancer diagnoses experienced by AYA patients is needed in order to improve outcomes in this population. The implication of our study, since no treatment center seems to produce superior survival, is that oncologists at pediatric and adult centers need to collaborate to perform clinic trials and to standardize treatment protocols for these patients. This is particularly true for patients who have one of the other carcinomas given the relatively poor outcomes for these patients compared to the other tumors in our study, and the incredibly small sample size of any one subtype. The Children's Oncology Group has proven that dedicating resources to AYA Oncology leads to increased study of these tumors, and this ultimately may facilitate joint cooperative group trials for rare pediatric tumors like it already has for more common pediatric malignancies [24, 25]. Increased participation in clinical trials is critical if any progress is to be made in closing the AYA gap.

Acknowledgements

Research Support: Supported by the National Center for Advancing Translational Sciences of the National Institutes of Health under Award Number UL1TR000454. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

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Figure 1.
Kaplan-Meier Estimates Comparing 10-Year Overall Survival by Type of Treatment Center

Table I

Comparison of Patient Characteristics Present at Diagnosis by Treatment Center (Adult vs. Pediatric) for 15-21-year-old Patients with Rare Pediatric Tumors Diagnosed Between 2000-2009 in the State of Georgia

Characteristic	Adult N (%)	Pediatric N (%)	P-value *
Total (N=479)	379 (79.1)	100 (20.9)	<0.01
Age [mean (SD)] (years)	18.9 ($\pm$ 1.8)	17.5 ($\pm$ 2.1)	<0.01
Age Group			<0.01
Young (15-18 years)	138 (36.4)	68 (68.0)	
Old (19-21 years)	241 (63.6)	32 (32.0)	
Race			0.01
Non-Hispanic White	286 (75.5)	65 (65.0)	
Black	56 (14.8)	30 (30.0)	
Hispanic White	20 (5.3)	4 (4.0)	
Other	12 (3.2)	1 (1.0)	
Unknown	5 (1.3)	0 (0.0)	
Gender			0.02
Male	109 (28.8)	41 (41.0)	
Female	270 (71.2)	59 (59.0)	
Follow-up Time [mean (SD)] (years)	5.4 ($\pm$ 3.0)	4.9 ($\pm$ 2.8)	0.15
Follow-up Time For Censored [mean (SD)] (years)	5.7 ($\pm$ 2.9)	5.3 ($\pm$ 2.7)	0.28
Diagnosis			<0.01
Thyroid Carcinoma	123 (32.5)	34 (34.0)	
Nasopharyngeal Carcinoma	11 (2.9)	14 (14.0)	
Other Carcinomas (46 subtypes)	93 (24.5)	33 (33.0)	
Melanoma [#]	152 (40.1)	19 (19.0)	
Stage			<0.01
Local	255 (67.3)	48 (47.0)	
Regional	96 (25.3)	34 (34.0)	
Distant	15 (4.0)	17 (17.0)	
Unknown Stage	13 (3.4)	1 (1.0)	
Primary Site			<0.01
Head & Neck	37 (9.8)	20 (20.0)	
GI	22 (5.8)	10 (10.0)	
Lung	7 (1.9)	7 (7.0)	
Skin	152 (40.1)	18 (18.0)	
GU	24 (6.3)	9 (9.0)	
Thyroid	123 (32.5)	34 (34.0)	

Characteristic	Adult N (%)	Pediatric N (%)	P-value *
Other	11 (2.9)	2 (2.0)	
Unknown	3 (0.8)	0 (0.0)	
Treatment			
Chemotherapy	43 (11.4)	30 (30.0)	<0.01
Surgery	353 (93.1)	79 (79.0)	<0.01
Radiation	102 (26.9)	52 (52.0)	<0.01
Combined	118 (31.1)	58 (58.0)	<0.01
None	15 (4.0)	3 (3.0)	1.00
Survival Status			0.36
Alive	345 (91.0)	88 (88.0)	
Dead	34 (9.0)	12 (12.0)	
Poverty Status (% below poverty line)			0.08
< 5%	101 (26.7)	16 (16.0)	
5% but < 10%	99 (26.1)	23 (23.0)	
10% but < 20%	96 (25.3)	28 (28.0)	
20%	76 (20.1)	31 (31.0)	
Unknown	7 (1.9)	2 (2.0)	
Poverty Group			0.07
Low Poverty	296 (78.1)	67 (67.0)	
High Poverty	76 (20.1)	31 (31.0)	
Unknown	7 (1.9)	2 (2.0)	
Average Distance to Closest Pediatric Center [mean (SD)] (miles)	38.1 (± 33.1)	33.8 (± 31.7)	0.24
Distance to Closest Pediatric Center			0.71
25 miles	189 (49.9)	50 (50.0)	
> 25 but 50 miles	90 (23.8)	27 (27.0)	
> 50 miles	100 (26.4)	23 (23.0)	

Abbreviations: SD=standard deviation, GI=gastrointestinal, GU=genitourinary

* P-value calculated by chi-square and Fisher's exact test for categorical variables and 2-sample t-test for continuous variables, 2-sided p-value calculated at alpha=0.05

site of melanoma: skin=18, ocular =1

Table II

Multivariate Analysis of the Association Between Patient Characteristics Present at Diagnosis and Treatment at a Pediatric Center for 15-21-year-old Patients with Rare Pediatric Tumors Diagnosed Between 2000-2009 in the State of Georgia

Characteristic	Odds Ratio For Treatment at a Pediatric Center	95% Confidence Interval	P-value *
Distance to Closest Pediatric Center			0.20
25 miles	Ref		
> 25 but 50 miles	1.28	0.70-2.35	
> 50 miles	0.65	0.34-1.28	
Diagnosis			0.01
Melanoma	Ref		
Thyroid Carcinoma	1.92	0.99-3.72	
Nasopharyngeal Carcinoma	7.38	2.30-23.75	
Other Carcinomas	2.64	1.25-5.60	
Stage			<0.01
Local	Ref		
Regional	1.63	0.92-2.88	
Distant	4.24	1.71-10.52	
Age Group			<0.01
Young (15-18 years)	Ref		
Old (19-21 years)	0.22	0.13-0.37	
Race			0.46
Non-Hispanic White	Ref		
Black	0.95	0.48-1.89	
Hispanic White	0.62	0.19-2.05	
Other	0.15	0.02-1.26	
Poverty Group			0.03
Low Poverty	Ref		
High Poverty	2.32	1.23-4.37	

Abbreviations: Ref=reference group

* P-value calculated using multivariate logistic regression model, 2-sided p-value calculated at alpha=0.05

Table III

The Effect of Center on Treatment by Diagnosis for all 15-21-year-old patients with Rare Pediatric Tumors Diagnosed between 2000-2009 in the State of Georgia

Diagnosis	Adult N (%)	Pediatric N (%)	P-value *
Thyroid Carcinoma (N=157)			
Chemotherapy	0 (0.0)	0 (0.0)	—
Surgery	119 (96.8)	33 (97.1)	1.00
Radiation	75 (61.0)	28 (82.4)	0.02
Combined	75 (61.0)	28 (82.4)	0.02
None	4 (3.3)	1 (2.9)	1.00
Other Carcinomas (N=126)			
Chemotherapy	32 (34.4)	15 (45.5)	0.26
Surgery	78 (83.4)	26 (78.8)	0.38
Radiation	18 (19.4)	10 (30.3)	0.19
Combined	31 (33.3)	15 (45.5)	0.21
None	9 (9.7)	1 (3.0)	0.45
Nasopharyngeal Carcinoma (N=25)			
Chemotherapy	7 (63.6)	14 (100.0)	0.03
Surgery	6 (54.6)	2 (14.3)	0.08
Radiation	9 (81.8)	14 (100.0)	0.18
Combined	8 (72.7)	14 (100.0)	0.07
None	0 (0.0)	0 (0.0)	—
Melanoma (N=171)			
Chemotherapy	4 (2.6)	1 (5.3)	0.45
Surgery	150 (98.7)	18 (94.7)	0.30
Radiation	0 (0.0)	0 (0.0)	—
Combined	4 (3.6)	1 (5.3)	0.45
None	2 (1.3)	1 (5.3)	0.30

* P-value calculated by chi-square and Fisher's exact test, 2-sided p-value calculated at alpha=0.05

Table IV

Multivariate Analysis of the Association Between 10-year Overall Survival and Treatment Center for 15-21-year-old Patients with Rare Pediatric Tumors Diagnosed Between 2000-2009 in the State of Georgia

Characteristic	Hazard Ratio For Death	95% Confidence Interval	P-value
Distance to Closest Pediatric Center			0.99
25 miles	Ref		
> 25 but 50 miles	0.95	0.44-2.06	
> 50 miles	0.95	0.45-2.00	
Facility			0.67
Adult	Ref		
Pediatric	0.83	0.36-1.92	
Diagnosis			<0.01
Melanoma	Ref		
Thyroid Carcinoma	0.05	0.01-0.41	
Nasopharyngeal Carcinoma	0.17	0.02-1.43	
Other Carcinomas	2.03	0.91-4.53	
Stage			<0.01
Local	Ref		
Regional	4.66	2.07-10.52	
Distant	20.97	7.73-56.89	
Age Group			0.16
Young	Ref		
Old	1.71	0.81-3.59	
Race			0.94
Non-Hispanic White	Ref		
Black	0.88	0.39-1.96	
Hispanic White	1.57	0.42-5.88	
Other	0.71	0.14-3.69	
Poverty Group			0.46
Low	Ref		
High	1.56	0.78-3.11	

Abbreviations: Ref=reference group

* P-value calculated using Cox proportional hazards model, 2-sided p-value calculated at alpha=0.05