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Predictors of Healthcare Utilization in Adult Survivors of Childhood Cancer Exposed to CNS-Directed Therapy

Cara Kimberg, PhD¹, James L. Klosky, PhD², Nan Zhang, MS³, Tara M. Brinkman, PhD^{1,2}, Kirsten K. Ness, PhD¹, Deo Kumar Srivastava, PhD³, Leslie L. Robison, PhD¹, Melissa M. Hudson, MD^{1,4}, and Kevin R. Krull, PhD^{1,2}

¹Department of Epidemiology and Cancer Control, St. Jude Children's Research Hospital

²Department of Psychology, St. Jude Children's Research Hospital

³Department of Biostatistics, St. Jude Children's Research Hospital

⁴Department of Oncology, St. Jude Children's Research Hospital

Abstract

Background—Survivors of childhood cancer treated with CNS-directed therapy may be at-risk for poor healthcare utilization due to neurocognitive deficits. This study examined associations between neurocognitive function and adherence to routine and risk-based medical evaluations in adult survivors exposed to CNS-directed therapy.

Methods—Neurocognitive function and healthcare utilization were assessed in 1304 adult survivors of childhood cancer enrolled in the St. Jude Lifetime Cohort Study. Adherence to recommended care was defined as meeting guidelines published by the Children's Oncology Group. Multivariable models were used to evaluate associations between neurocognitive function and health screenings. Established predictors of healthcare utilization were included as covariates. Odds ratios (OR) or prevalence ratios (PR) and 95% confidence intervals (CIs) were calculated for variables maintained in the final models.

Results—Adherence to recommended medical care was higher for routine (general physician care: 57.6%; dental care: 49.1%) as opposed to specialized care (survivor-focused care: 21.9%; echocardiogram: 19.9%). Higher intelligence was predictive of general physician care (OR=1.74, 95% CI=1.41 - 2.15) and survivor-focused care (OR=1.44, 95% CI=1.13 - 1.83) compared to no care, while better executive function skills were associated with reduced dental care (PR = 0.94, 95% CI = 0.91-0.98). Echocardiogram monitoring was not associated with neurocognition. Possible late-effects of cancer treatment (pain, reduced cardiorespiratory fitness) were associated with an increased likelihood of receiving specialized medical care.

Conclusion—Survivors with reduced global cognition are at risk for poor healthcare utilization. Education practices regarding recommended healthcare should be personalized to ensure comprehension by survivors with neurocognitive impairment.

Corresponding Author: Cara Kimberg, PhD, St. Jude Children's Research Hospital, Department of Epidemiology and Cancer Control, 262 Danny Thomas Place, MS 735, Memphis, TN 38105, Telephone: 901-595-5681; fax: 901-595-5845, address: cara.kimberg@stjude.org.

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Keywords

childhood cancer; long-term survivors; healthcare utilization; neurocognition; late-effects

Introduction

Therapeutic advances have led to a growing population of childhood cancer survivors, with recent estimates indicating that one in every 750 adults in the United States is a long-term survivor¹. This population is at-risk for treatment related morbidities; recent findings from the St. Jude Lifetime Cohort Study (SJLIFE) demonstrated that 95.5% of childhood cancer survivors will have at least one chronic health condition by 45 years of age². Engagement in routine medical care and screening based on treatment exposure is critical for the early detection and management of chronic health conditions; however, adherence to recommended care is variable³⁻⁶.

In the general population, adherence to recommended health screenings is approximately 60 to 70%⁷. Utilization rates differ between children and adults, with adults receiving less preventative care. Healthcare utilization among childhood cancer survivors varies according to service type. While adherence to routine medical care ranges from 72 to 89%, the proportion of survivors adhering to risk-based screening recommendations is significantly lower (echocardiogram: 29.4%; mammogram: 41.1%; colonoscopy: 14.3%)^{3, 4}.

In the general population, barriers to optimal healthcare utilization include lack of insurance, limited access to providers, and demographic characteristics such as gender, age, income, and education level^{8, 9}. In non-cancer populations, neurocognitive impairment is a predictor of less frequent physician and dental care¹⁰⁻¹². As nearly half of adult survivors of childhood cancer exposed to central nervous system (CNS) treatment have identified neurocognitive impairment², these survivors may be at significant risk for poor adherence to recommended healthcare.

A recent report from the Childhood Cancer Survivor Study (CCSS) linked patient-reported cognitive symptoms to recommended healthcare evaluations as outlined by the Children's Oncology Group (COG) Long-Term Follow-Up Guidelines^{3, 13}. Notably, patient self-reported ratings of cognitive abilities are often discrepant with direct performance-based neurocognitive measures due to factors such as response shift and emotional distress^{14, 15}. Further, cognitive impairments may impede patients from accurately assessing functional and skill-based limitations¹⁶.

Thus, the aims of the current study were to determine rates of healthcare utilization in adult survivors of childhood cancer treated with CNS directed-therapy and to examine the association between performance-based neurocognitive function and recommended medical care. We hypothesized that survivors with neurocognitive impairment would demonstrate poorer healthcare utilization compared to survivors without impairment. Understanding the impact of cognitive function on healthcare practices is a critical first step towards the development of interventions aimed to promote engagement in routine medical care and risk-based screenings.

Methods

Participants were recruited from the SJLIFE cohort, which includes survivors of childhood cancer treated at St. Jude Children's Research Hospital (SJCRH) who are at least 18 years of age and 10 years post-diagnosis². All survivors treated at SJCRH for a pediatric malignancy are eligible for SJLIFE, once current age and time since diagnosis criteria have been met. Approximately 75% of eligible survivors complete on-campus comprehensive health evaluations (please see Hudson et al for more detailed descriptions of the SJLIFE study design^{2,17}). A recent report compared participants eligible for SJLIFE to those enrolled on the cohort study across demographic, disease and neighborhood-level socioeconomic variables. Results indicated that differences between participants and nonparticipants were not substantial limiting potential bias secondary to nonparticipation¹⁸.

To be eligible for the current study, survivors were enrolled in SJLIFE from October 1, 2007 through April 30, 2012, and were required to be at-risk for neurocognitive impairment based on the COG Long-Term Follow-Up Guidelines¹³. Survivors had to complete standardized neurocognitive testing and comprehensive questionnaires regarding emotional function, health behaviors and demographic characteristics. As such, findings from the current study may generalize only to cancer survivors treated with similar neurotoxic therapies. Exclusion criteria included a recent visit to SJCRH during which recommended healthcare evaluations were provided. All participants gave written informed consent and approval was obtained from the institutional review board.

Primary Outcomes, Specific Study Samples, and Measurement

Physician Care—At the time of analysis, 2473 survivors were enrolled in SJLIFE. Of these participants, 1143 survivors met study eligibility and were included in the physician care outcome analysis. Participants were excluded if they had not been treated with CNS-directed therapy (n = 943), did not complete the neurocognitive evaluation (n = 47), were unable to complete questionnaires independently (n = 163) or had received medical care at SJCRH within the two years prior to their initial SJLIFE clinical assessment (n = 177). Although it is recommended that survivors receive an evaluation by a physician annually, the current study defined adherence as receiving physician care at least once within the past two years. Survivors indicated if their healthcare visits related to their original cancer diagnosis and responses were categorized as 1) no physician care, 2) general physician care, or 3) general survivor-focused care³.

Dental Care—As dental care is not a routine service provided by SJCRH to long-term survivors, participants were not excluded from analyses relating to dental care, even if they had received recent medical care at SJCRH. A total of 1304 participants were included in the dental care outcome analysis. Although it is recommended that survivors receive a dental exam and cleaning every 6 months, for the current study adherence to dental care was defined as report of at least one dental visit in the past year.

Echocardiogram—To be included in the echocardiogram outcome, survivors had to be at-risk for cardiac toxicity based on childhood cancer treatment exposure with anthracycline chemotherapy and/or chest-directed radiotherapy. Recommended frequency of

echocardiogram was based on the COG Long-Term Follow-Up Guidelines, which considers age at treatment, as well as chest radiation and anthracycline dose¹³. A total of 673 survivors were included in the echocardiogram outcome analyses. Survivors were excluded if they were not exposed to anthracycline chemotherapy or chest-directed radiotherapy (n = 750), had received the recommended echocardiogram at SJCRH (n = 264), did not receive CNS-directed therapy (n = 654), did not complete a neurocognitive evaluation (n = 27) or did not complete the questionnaires independently (n = 105). Adherence to this risk-based screening evaluation was defined as reporting an echocardiogram at the recommended interval based on individual treatment characteristics.

Predictors and Covariates

Neurocognitive Predictors—Neurocognitive function was assessed in five domains, each represented by a single variable: overall reasoning ability (Full Scale Intelligence-Wechsler Abbreviated Scale of Intelligence)¹⁹, attention (Variability-Conners' Continuous Performance Task-Second Edition)²⁰, processing speed (Processing Speed Index-Wechsler Adult Intelligence Scale-Third Edition)²¹, memory (Verbal Learning-California Verbal Learning Test-Second Edition)²², and executive function (Cognitive Flexibility-Trail Making Test Part B)²³. Performance scores were transformed into age-adjusted standard scores (mean = 0; SD = 1) based on population norms.

Emotional and Physical Characteristics—Emotional function was assessed through survivor self-report of antidepressant and anxiolytic use and the Brief Symptom Inventory-18 (BSI-18)²⁴. For the BSI-18 gender-specific scores were calculated for the depression, anxiety and somatization sub-scales using a community-based normative sample. Survivors were considered to have excess symptoms of depression if they reported taking antidepressants and/or their T-score on the BSI-18 depression subscale was ≥ 63 . Similarly, excess symptoms of anxiety were considered to be present if survivors reported taking an anxiolytic and/or their T-score on the BSI-18 anxiety subscale was ≥ 63 . Elevated levels of somatization were evaluated by the BSI-18 (T-score ≥ 63 was considered clinically significant). Survivors also rated their level of bodily pain during the past four weeks. Responses were dichotomized into: 1) no or mild pain (none, very mild, mild) and 2) pain (moderate, severe, very severe).

Physical function was evaluated with the six-minute walk test²⁵. Distance walked in 6-minutes was compared to healthy controls and impairment was defined as performance $<10^{\text{th}}$ percentile. Body mass index (BMI) was calculated according to Center for Disease Control (CDC) guidelines and dichotomized into overweight/obese (BMI ≥ 25) and normal/low weight (BMI ≤ 24.9)²⁶.

Demographic Characteristics—Demographic characteristics associated with healthcare utilization practices, as outlined above, were selected as covariates^{3, 5, 27-29}. Variables were categorized based on sample distribution: current age at evaluation (<20 years, 20-29 years, 30-39 years, ≥ 40 years), time since diagnosis (10-19 years, ≥ 20 years), gender (male, female), race (Caucasian, other), education (some college, college), marital status (single, married or living as married, divorced or separated), living arrangement (dependent,

independent), household income (\$39,999, \$40,000), health insurance (yes, no), and dental insurance (yes, no).

Statistical Analysis

Descriptive statistics were calculated for medical care outcomes, neurocognitive predictors and covariates. Neurocognitive impairment was defined as a z-score -1.3 standard deviations below the mean. Since the physician care outcome was categorized into three levels, a multinomial generalized logistic regression model was employed to evaluate the relationship between neurocognitive function and physician care. The dental care and echocardiogram outcomes were dichotomized into two levels (those receiving the recommended dental care vs. no dental care and those getting the recommended echocardiogram vs. no echocardiogram) and the relative risk of receiving dental care/an echocardiogram were modeled using log-binomial regression models since the prevalence of the outcomes are about or higher than 20%³⁰. A two stage approach was adopted for selecting the best models. In the first stage all predictors that were significant at level $p < 0.20$ were selected. Associations with the selected predictors were subsequently assessed using the Akaike Information Criterion (AIC), which promotes model parsimony by applying a penalty function for models with more covariates. Therefore, the model with the lowest AIC was considered optimal³¹. Among the variables that were not significant at 0.05 level at this stage, the least significant predictor was removed and the new model was considered acceptable if the increase in AIC value was < 10 units³². This procedure was continued until the final model, with all insignificant factors (change in AIC value of < 10) removed was obtained. Odd ratios (OR) or prevalence ratios (PR) and 95% confidence intervals (CIs) were calculated for variables maintained in the final models. All analyses were performed in SAS version 9.3 (Cary, N.C.).

Results

Demographic and treatment characteristics are presented in Table 1. Survivors were on average 31.6 years of age at the time of their neurocognitive assessment and 24.1 years (range: 10.5 – 47.8 years) from their primary cancer diagnosis. The majority had a childhood cancer diagnosis of leukemia (66.9%) and 52% of survivors had received cranial radiation. Information on primary neurocognitive predictors, as well as emotional and physical covariates is included in Figure 1. Prevalence of impairment across cognitive domains ranged from 11.0% to 40.6% with higher prevalence demonstrated on executive function, attention and memory tasks. Pain was reported by 25% of survivors, while 38% were considered overweight or obese based on BMI.

Adherence to recommended healthcare was variable across medical outcomes (see Table 2). Approximately 16% of survivors reported receiving no physician care and 49% reported receiving recommended dental care. Of the 673 survivors exposed to cardiotoxic therapy and recommended to receive echocardiogram screening, only 20% reported having been screened.

Physician Care

The final multivariable model identified cognitive, emotional and socio-demographic characteristics as predictors of physician-based care (see Table 3). Higher overall reasoning skills were associated with more physician care (general care OR = 1.74, 95% CI = 1.41 – 2.15; survivor-focused care OR = 1.44, 95% CI = 1.13 – 1.83) compared to no care. Specifically, for every one standard deviation increase in Full Scale IQ, survivors were 74% more likely to report general physician care and 44% more likely to report having received survivor-focused care. Other cognitive skills were not retained in the final physician care model. Report of symptoms of depression and/or use of an antidepressant (general care OR = 1.66, 95% CI = 1.01 – 2.72; survivor-focused care OR = 2.19, 95% CI = 1.27 – 3.75) and symptoms of pain (OR = 2.73, 95% CI = 1.58 – 4.74) were associated with increased likelihood of having received physician care. Although the overall effect of years from diagnosis was predictive of physician care, the individual levels were non-significant. Survivors 10-19 years post-diagnosis were more likely to receive survivor-focused care or general care compared to survivors who were more than 20 years from diagnosis (data not shown).

Dental Care

Significant predictors of adherence to routine dental care included neurocognitive, physical and demographic variables (see Table 4). Dental insurance was associated with an increased likelihood of reporting dental care compared to no care (PR = 1.82, 95% CI = 1.58-2.10). In contrast, better executive function and poorer physical endurance, as evaluated by the six-minute walk test, were associated with reduced dental care.

Echocardiogram

Only insurance (PR = 1.83, 95% CI = 1.12 – 3.00) and poor physical endurance (PR = 1.42, 95% CI = 1.04 – 1.95) were significantly associated with report of echocardiogram. Cognitive and emotional variables were not significantly associated with cardiac risk-based screening and were dropped from the final model.

Discussion

This study identifies a novel predictor of participation in routine medical care, overall reasoning abilities, which were associated with receiving general and survivor-focused physician care. Importantly, for every one standard deviation increase in general intellectual function, survivors were 74% more likely to report routine healthcare, a finding that is statistically and clinically meaningful.

Research has largely focused on the relationship between specific cognitive skills and healthcare utilization, as opposed to general intellectual function^{3, 33}. The identification of specific cognitive deficits enables the implementation of targeted interventions (i.e. receiving a handout that outlines recommended medical care) to increase healthcare utilization. However, the predictive value of a global index of functioning also has several benefits. First, overall reasoning skills can be evaluated using screening tools that take approximately 15 minutes to administer. Such measurement instruments have large

normative samples, good psychometric properties and are reliable proxies for more comprehensive measures of intellectual functioning¹⁹. Additionally, a global index of functioning is typically included in cognitive assessment batteries, whereas inclusion of instruments to measure cognitive domains (attention, memory, executive function) is more variable. Evaluating specific neurocognitive domains presents challenges as there are many sub-domains, each linked with a different real-life skill. Further, there are many tools available to measure these skills, including both direct-assessment and self-report measures, with limited agreement among researchers and clinicians as to which instrument is ideal; thus, it can be challenging to generalize findings across studies. For instance, in CCSS self-reported difficulties with organization were associated with less dental care, while perceived impairments with task efficiency predicted increased physician care³. It is unclear how these findings relate to the findings of the current study. Importantly, awareness of an individual's global level of function can guide education efforts (i.e. word selection, amount of details provided) regarding treatment related risks and the importance of obtaining recommended healthcare, over and beyond knowledge of specific skill deficits.

Body pain was also associated with report of survivor-focused physician care compared to no care, which is not surprising as pain reported as a late-effect of treatment may stimulate survivors to pursue more specialized care. This finding provides an avenue for intervention of risk-based care prior to the onset of pain symptoms. Specifically, education regarding the potential expression of chronic health conditions and pain secondary to cancer treatment may promote engagement in targeted preventative care³⁴.

Symptoms of depression were associated with increased physician care, while anxiety and somatization were not predictive of healthcare utilization. Studies in the general population have identified both depression and anxiety as predictive of healthcare practices^{29, 35}. In a study of older adults, an increase in depressive symptoms was associated with an increase in missed medical appointments. Notably this study did not take into consideration current use of antidepressant medication²⁹. Previous research has found that survivors who report the greatest number of health concerns and cancer-related worries, as well as poor health status, were less likely to receive risk-based screenings³⁶. In contrast, adult patients diagnosed with generalized anxiety disorder were found to have more medical encounters than a matched comparison group without generalized anxiety disorder³⁵. It would be interesting to see if anxiety specific to health-related concerns or a clinical diagnosis of an anxiety disorder would be predictive of healthcare practices in our current sample.

Higher executive function was predictive of reduced dental care. Executive function skills are associated with higher educational attainment and professional employment^{37, 38}, as well as adherence to medication regimens³⁹. Therefore, it is initially counterintuitive that survivors with better executive function would have worse attendance at dental visits. However, these survivors may be functioning at higher professional positions and have more complex schedules which make it more challenging to attend dental appointments regularly⁴⁰, the threshold for attending health-related appointments may be lower.

Cognitive status and emotional health were not predictive of receiving an echocardiogram. It is possible that these relationships were not identified due to the small number of survivors

who obtained the recommended cardiac evaluation. In contrast, individuals with poor performance on the 6-minute walk test, a proxy for general cardiorespiratory fitness, were more likely to receive an echocardiogram. Therefore, the echocardiogram may have been obtained in response to cancer-related late effects that were already impacting daily function (i.e. reduced physical fitness), rather than as a preventative screening tool. This paradigm is similar to that observed with pain symptoms and again suggests the need for early and effective education regarding treatment-related health risks.

Other predictors of healthcare utilization identified in the current study were generally commensurate with previous research^{3, 4}. Insurance was the strongest predictor of our three medical outcomes; individuals who reported having health insurance were 3-times more likely to receive general physician care and 1.8-times more likely to have an echocardiogram. Survivors with dental insurance were 1.8-times more likely to receive regular dental care. Notably, insurance was associated with a 6-fold increased likelihood of receiving survivor-focused physician care compared to no care suggesting that more comprehensive and targeted physical evaluations are closely related to insurance status. These findings highlight the importance of health and dental insurance. Multidisciplinary teams should confirm that uninsured individuals have the knowledge and resources to apply for insurance coverage. Assistance should be provided to survivors who are unable, potentially secondary to cognitive impairment, to navigate the application system independently. Additionally, information regarding low cost clinics should be provided. For purposes of the current study public v. private insurance type was not modeled due to the small number of survivors who reported having Medicaid (6%) compared to private insurance (70%). Descriptive analyses indicated survivor-focused care was reported at a higher frequency by survivors with Medicaid (43.2%) compared to survivors with private insurance (24.2%). As survivor-focused care is associated with risk-based screening evaluations, it is beneficial to identify factors that promote this type of evaluation⁴.

The current study has several limitations. First, it is unknown if survivors had knowledge of their treatment-related risks and the associated recommended screening evaluations. Although it is current practice during active treatment and in after therapy care to discuss late effects and long-term follow-up, many of the SJLIFE patients included in the current study received treatment decades before survivorship guidelines and risk factors were well established. Therefore, it is important to determine rates of healthcare utilization in more contemporary cohorts. Further, medical care was collected through survivor self-report. Since the study population was comprised of individuals at-risk for neurocognitive impairment, and a greater proportion of survivors demonstrated memory impairment than expected, it is possible that attendance at medical visits was misreported. However, given that the average global intellectual functioning index for this cohort is within normal limits frequent false reports of medical care outcomes are less likely. Lastly, survivors who did not complete study questionnaires independently, potentially secondary to severe cognitive impairment, were excluded from analyses. Although this limits study generalizability, it is expected that survivors with significant cognitive dysfunction receive support from caregivers and are not independently responsible for scheduling and attending medical appointments.

In summary, the current findings indicate that rates of healthcare utilization among childhood cancer survivors are variable, with poorer adherence demonstrated for more specialized care. Predictors of healthcare include cognitive, emotional and demographic characteristics. Insurance was identified as the strongest predictor of medical care; however, even after adjusting for insurance, better overall reasoning skills were associated with attendance at physician-based care. This suggests that individuals with cognitive impairment are at-risk for poor engagement with healthcare systems. Further, medical care was associated with possible treatment-related late-effects, indicating that survivors' current healthcare practices may be for the management, rather than prevention, of health conditions.

These results highlight the value of educating survivors about treatment-related risks prior to the onset of symptoms. Teaching content and practices may need to be modified to ensure comprehension by survivors with neurocognitive impairment. As long-term follow-up guidelines are revised periodically, it will be critical that survivors are informed of changes to their recommended healthcare evaluations. Additionally, it will be important to verify that survivors are aware of and understand the steps necessary to schedule medical appointments, as well as have the necessary support (i.e. reminders, family members) to attend these visits. Importantly, as neurocognitive late-effects change overtime,³⁷ regular monitoring of cognitive function is critical, as education approaches and support systems for an individual may need to be modified based on declines in cognition. Future directions include evaluating adherence to community-based evaluations/interventions that are recommended during survivorship care. Further, as insurance was the strongest predictor of healthcare in the current study, it will be essential to track changes in survivors' healthcare utilization rates secondary to the implementation of the Affordable Care Act.

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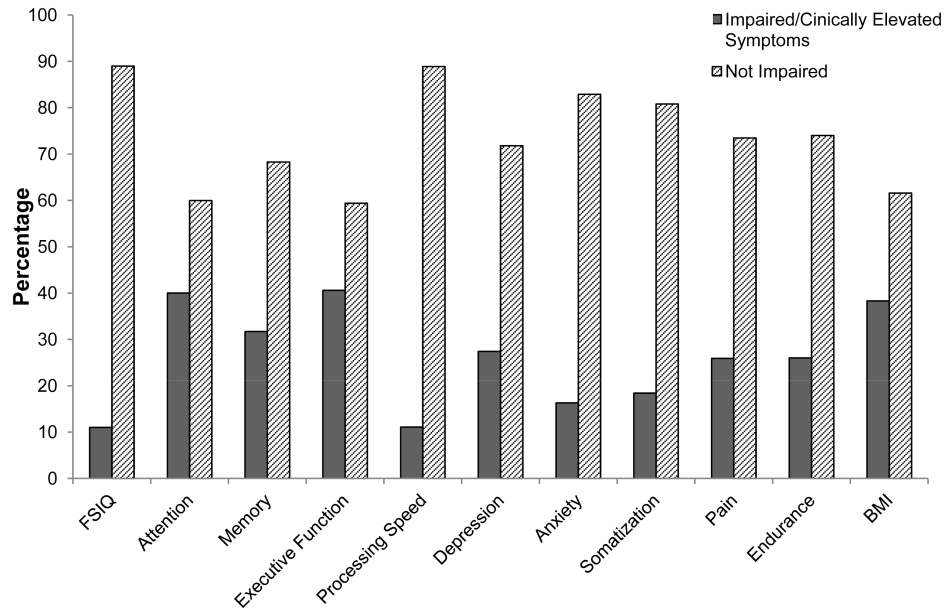


Figure 1. Neurocognitive, Emotional and Physical Characteristics

The percentage of participants with impaired/clinically elevated symptoms versus not impaired across neurocognitive, emotional and physical variables. The expected rate of impairment for cognitive variables is the 10th percentile. Symptoms of depression and anxiety are considered clinically elevated if T-scores ≥ 63 on BSI-18 and/or report of antidepressant or anxiolytic medication, respectively. T score ≥ 63 is considered clinically elevated for somatization. Percentages are based on participants with available data.

Table 1
Demographic and Treatment Characteristics of Survivors Exposed to CNS-Directed Therapy (N= 1304)

	Mean	SD
Age at Evaluation (years)	31.6	7.9
Age at Diagnosis (years)	7.5	5.0
	N	%*
Age at Evaluation (years)		
18-30	637	48.8
31-40	472	36.2
>40	195	15.0
Age at Diagnosis (years)		
0-4	486	37.3
5-9	368	28.2
10-14	306	23.5
15	144	11.0
Time since Diagnosis (years)		
10-19	439	33.7
20	865	66.3
Gender		
Male	654	50.2
Female	650	49.8
Ethnicity		
Caucasian	1145	87.8
Other	159	12.2
Education		
Some college	790	62.5
College	474	37.5
Marital Status		
Single, never married	488	38.6
Married, living as married	601	47.6
Divorced, no longer living as married	175	13.8
Living Arrangement**		
Dependent	390	29.9
Independent	914	70.1
Household Income		
<\$40,000	520	47.2
\$40,000	582	52.8
Health Insurance		
Yes	996	76.7
No	302	23.3

	Mean	SD
Dental Insurance		
Yes	696	55.8
No	552	44.2
Diagnosis ⁺		
Leukemia	872	66.9
Lymphoma	129	9.9
CNS Tumor	142	10.9
Embryonal	26	2.0
Bone and Soft Tissue Sarcoma	111	8.5
Other	24	1.8
Radiation ⁺		
Chest	212	16.3
Cranial (CRT)	674	51.7
Chemotherapy ⁺		
Anthracyclines	825	63.3
Alkylating Agents	860	66.0
Antimetabolites	990	75.9
Anti-Tumor Agents	67	5.1
Corticosteroids	952	73.0
Platinum	122	9.4
CNS Directed Therapy ⁺		
HD/IV/IT/IO MTX [‡]	1036	79.5
HD Ara-C ^{‡‡}	105	8.1
HD/IV/IT/IO MTX and HD Cytarabine	1057	81.1
HD/IV/IT/IO MTX and CRT	1196	91.2
HD Ara-C and CRT	725	55.6
HD/IV/IT/IO MTX, HD Ara-C and CRT	1199	92.0

* Percentages based on participants with available data

** independent living (living alone, with a spouse/roommate or as a caretaker); dependent living (living with parents/family)

⁺ variable not included in multivariable models

[‡] high dose/intravenous/intrathecal/intra-omaya methotrexate

^{‡‡} high dose cytarabine

Table 2**Healthcare Utilization**

	Recommended N*	N	%
Physician Care	1143		
No Care		189	16.5
General Care		658	57.6
Survivor-Focused Care		250	21.9
Missing		46	4.0
Dental Care	1304		
No		664	50.9
Yes		640	49.1
Echocardiogram	673		
No		391	58.1
Yes		134	19.9
Missing		148	22.0

* includes survivors eligible for analysis based on inclusion/exclusion criteria

Table 3
Multivariable Model Predicting Physician Care Among Survivors Exposed to CNS-Directed Therapy

	Physician Care	OR*	95%CI	p-value
Overall Reasoning (continuous z-score)				<.0001
	No Care	1.0		
	General	1.74	1.41 – 2.15	
	Survivor	1.44	1.13 – 1.83	
Years since Diagnosis (10-19 vs. 20 years)				0.005
	No Care	1.0		
	General	0.68	0.44 – 1.03	
	Survivor	1.18	0.73 – 1.91	
Gender (female vs. male)				0.036
	No Care	1.0		
	General	1.53	1.03 – 2.26	
	Survivor	1.80	1.14 – 2.83	
Body Pain (moderate vs. mild)				<0.001
	No Care	1.0		
	General	1.53	0.93 – 2.53	
	Survivor	2.73	1.58 – 4.74	
Symptoms of Depression (yes vs. no)				0.017
	No Care	1.0		
	General	1.66	1.01 – 2.72	
	Survivor	2.19	1.27 – 3.75	
Marital Status (single vs. married)				0.01
	No Care	1.0		
	General	0.63	0.43 – 0.94	
	Survivor	0.95	0.60 – 1.51	
Insurance (yes vs. no)				<.0001
	No Care	1.0		
	General	3.21	2.16 – 4.77	
	Survivor	6.05	3.58 – 10.23	

* OR = Odds Ratio

Table 4
Multivariable Model Predicting Dental Care Among Survivors Exposed to CNS-Directed Therapy

		PR*	95% CI	p-value
Overall Reasoning (continuous z-score)	No Care	1.0		
	Dental	1.04	0.97 – 1.12	0.29
Executive Function (continuous z-score)	No Care	1.0		
	Dental	0.94	0.91- 0.98	0.001
Attention (continuous z-score)	No Care	1.0		
	Dental	0.98	0.93 – 1.03	0.46
Processing Speed (continuous z-score)	No Care	1.0		
	Dental	1.06	0.99 – 1.13	0.11
Body Pain (moderate, severe, very severe vs. none, mild, very mild)	No Care	1.0		
	Dental	0.88	0.75 – 1.02	0.10
Symptoms of Somatization (yes vs. no)	No Care	1.0		
	Dental	0.93	0.77 – 1.12	0.45
Ethnicity (Other vs. Caucasian)	No Care	1.0		
	Dental	0.82	0.66 – 1.02	0.07
Marital Status (single, divorced vs. married, living as married)	No Care	1.0		
	Dental	0.95	0.86 – 1.06	0.37
Dental Insurance (yes vs. no)	No Care	1.0		
	Dental	1.82	1.58 – 2.10	<.0001
Physical Endurance (impaired vs. not impaired)	No Care	1.0		
	Dental	0.86	0.74 – 0.99	0.036

* PR = prevalence ratio