1. STUDY TITLE: Health-Related Locus of Control in Childhood Cancer Survivors

2. WORKING GROUP AND INVESTIGATORS:

   2.1 Working groups: Psychology/Neuropsychology; Cancer Control

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3. BACKGROUND AND RATIONALE:

Adult survivors of childhood cancer are at risk for medical, psychosocial and cognitive late effects. The Children's Oncology Group Long-Term Follow-Up Guidelines for Survivors of Childhood, Adolescent and Young Adult Cancers provide recommendations for risk-based screening based on treatment exposures[1]. Screening procedures allow for the early identification, intervention and management of diseases and disorders with the goal of reducing morbidity and mortality. Despite advances in medicine, which enable early identification, medical screening is often underutilized[2]. This is particularly worrisome in the cancer survivor population due to the heightened risk of secondary cancers, obesity, as well as cardiovascular, pulmonary, cognitive and emotional late effects. In order to develop programs and interventions to promote medical screening and positive health behaviors (i.e., physical activity, sunscreen use, eating habits) it is important to understand factors that predict health-related behaviors. Research suggests that adherence behaviors are influenced by a myriad of factors including cognitive status, emotional functioning, knowledge of disease management, and demographic characteristics (i.e., access to medical care, insurance, socioeconomic status)[3].

The health belief model has been used to explain patterns of health behaviors, healthcare utilization, initial linkage to medical care and retention in care[4]. This model is based on the idea that "health behaviors are expressions of health beliefs" and includes perceived: 1) vulnerability to disease, 2) benefits of receiving care, and 3) barriers to preventative behavior, as well as the intrinsic and extrinsic factors that promote positive health behavior.[5, 6, 7, 8,9] Health locus of control, or the degree to which a person believes that he/she can control what happens to him/her, is an important component of the health belief model. An internal health locus of control suggests the belief that life events are directly under a person's own control and that future events, both positive and negative, result from his/her own actions. In contrast, an

external health locus of control suggests that life events are caused by either "powerful others" (i.e., people that control life events, such as family, friends, medical professionals, and/or religious figures), or by "chance" events (i.e. fate, luck)[10]. With respect to illness, externally oriented people tend to believe that they have no control over their own health status, while internally oriented people attribute health to their own actions. Thus, an internal health locus of control belief system has been associated with several positive health-behaviors, including smoking cessation, weight loss, dental check-ups and adherence to recommendations made by a medical team[8].

Despite the established association between health locus of control and health behaviors, this relationship has been understudied in cancer survivors. A study by Smith and colleagues[11] identified factors that influence adherence to mammography screening guidelines in survivors at high risk for breast cancer due to treatment exposure. Among survivors who received a physician's recommendation, had positive perceptions of mammography and rated themselves high on the active-planning coping scale, an internal locus of control was associated with reduced adherence to screening guidelines. This finding supports the complex interplay between health beliefs and behaviors. Accordingly, in another study of childhood cancer survivors, the impact of survivors' internal motivation to engage in recommended healthcare utilization was dependent on current and future health concerns, as well as perception of current health status[12].

Taken together, the evidence linking health beliefs to engagement in health behaviors is inconsistent. Wallston and Wallston[13, 14], the developers of a widely utilized health locus of control scale, suggest that the underlying reason for equivocal findings may be due to the manner in which this concept is utilized. In other words, researchers often employ each of the locus of control scales independently without taking into consideration that the pattern of responses across scales may be more sensitive to outcomes. Thus, in order to increase the predictive power of health beliefs it was suggested that individuals be categorized into possible types, based on whether they score high or low across the three scales (internal, chance, powerful others). This approach was utilized in a study by Rock and colleagues[13] and six independent clusters were identified based on the pattern of responses across locus of control scales. Importantly, this study was conducted with healthy individuals and it was hypothesized that identified clusters may vary based on sample characteristics.

The current concept proposes to explore the influence of health beliefs in the Childhood Cancer Survivor Study (CCSS) cohort. A subset of participants enrolled in CCSS (n = 975) completed the Health Care Needs Survey (please see Table 1 for sample characteristics). Included in the survey is the Multidimensional Health Locus of Control Scale (Form A)[10] which provides scores across internal, chance and powerful other health belief scales. Importantly, locus of control scales have been determined to have adequate stability in individuals who have not experienced a new significant medical or psychosocial stressor. Since health locus of control has not, to our knowledge, been explored in adult survivors of childhood cancer using this typology approach, it is important to characterize the health beliefs of cancer survivors and determine if treatment-related factors and/or current demographic characteristics predict locus of control styles. Subsequently, this study aims to investigate the influence of health beliefs on

health-related behavior, including medical screenings, physical activity, weight status, and sunscreen use. An inherent limitation of this study is that participants are not reporting on their locus of control styles during the same timeframe for which they are reporting on health behaviors and healthcare utilization. Despite this limitation, the current proposal has the ability to inform future intervention studies that can tailor information about health behavior and medical screening to an individual's health belief style[15].

4. SPECIFIC AIMS/OBJECTIVES/RESEARCH HYPOTHESES:

4.1. Primary Aims:

4.1.1. To characterize the locus of control styles reported by adult survivors of childhood cancer.

4.1.2. To examine the relationship between treatment factors and locus of control styles.

4.1.3. To examine the impact of locus of control health belief systems on health behaviors and adherence to recommended healthcare utilization.

4.2. Hypotheses:

4.2.1. There will be multiple patterns of locus of control styles in cancer survivors[13]: 1) pure internal (high internal, low chance and powerful others), 2) pure powerful others external (high powerful others, low internal and chance), 3) pure chance external (high chance, low internal and powerful others), 4) double external (high chance and powerful others, low internal), 5) believer in control (high internal and powerful others, low chance), 6) yea-sayer (high on all scales), 7) nay-sayer (low on all scales)

4.2.2a. Survivor demographic characteristics (e.g. age, sex, employment) will be associated with locus of control style.

4.2.2b. Survivor treatment characteristics (e.g. treatment regimen, age at diagnosis) will be associated with locus of control styles.

4.2.3a. Survivors with a pure internal locus of control style (class 1) will be more likely to have a BMI in the average range, as well as engage in recommended physical exercise and sunscreen use, after controlling for factors that are known to be associated with BMI, exercise and sunscreen use. *(Classes of locus of control styles will predict health behaviors).*

4.2.3b. Survivors with a believer in control style (class 5) will be more likely to adhere to risk-based medical care and routine dental care. *(Classes of locus of control styles will predict adherence to medical screening).*

5. ANALYSIS FRAMEWORK:

5.1 Specific Aim 1:

Subject Population

1. Inclusion Criteria
    a. CCSS survivors who completed the Health Care Needs Survey independently (survey dates: 2/2001 to 10/2001)
2. Sample Size

a. Estimated n = 975

3. Outcome Measures
    a. Health Locus of control (The score on each subscale is the weighted sum of the item [1 = strongly disagree→ 6 = strongly agree]; no items need to be reversed before scoring. Scores will be pro-rated if at least four items on each scale are completed).
        i. Internal (Health Care Needs Survey Questions E.1, E.6, E.7, E.11, E.12, E.16)
        ii. Chance (Health Care Needs Survey Questions E.2, E.4, E.8, E.10. E.14, E.15)
        iii. Powerful Others (Health Care Needs Survey Questions E.3, E.5, E.9, E.13, E.17)
4. Statistics-
    a. Analyses for Aim 1 will use the approach from the study conducted by Rock and colleagues [11] which aimed to determine and replicate classes of locus of control styles through K-Means cluster analysis. This approach was utilized to determine if the pattern of responses across the locus of control scales was more predictive of health behavior compared to looking at each scale independently. We will calculate 5, 6, and 7 cluster solutions and employ the following criteria in order of importance to select the optimal solution:
        i. Interpretability of the obtained subgroups using the 7 theoretically driven classes: 1) pure internal (high internal, low chance and powerful others), 2) pure powerful others external (high powerful others, low internal and chance), 3) pure chance external (high chance, low internal and powerful others), 4) double external (high chance and powerful others, low internal), 5) believer in control (high internal and powerful others, low chance), 6) yea-sayer (high on all scales), 7) nay-sayer (low on all scales). The eighth potential class (high internal and chance, low powerful others) is not included as it is not clinically meaningful. These classes are further defined in the following way. (Please note mean score refers to the mean scores for MHLC Scales for Healthy adults-see below):
            1. Pure internal: Internal [I] > mean; chance [C], powerful others [P] < mean
            2. Pure powerful others: I, C <mean; P > mean
            3. Pure chance external: I, P < mean; C > mean
            4. Double external: I < mean; C,P > mean
            5. Believer in control: I,P > mean; C < mean
            6. Yea-sayer: I,C,P > mean
            7. Nay sayer: I,C,P < mean

Multidimensional Locus of Control Scale: Normative data (N = 1287)[16]

	Internal (mean)	External (mean)	Powerful Others (mean)
Healthy adults	25.55	16.21	19.16

ii. Cluster size: Clusters must include at least 102 participants (sample size calculated with g-power using an estimated 11 predictors at 80% power, alpha = .10).
iii. The euclidean distance measure, a value that indicates if the average difference between clusters is greater than the average difference within each cluster, will be employed to demonstrate the fit of the model.

c. After the selection of the cluster solution the following procedures will be used to determine reliability:
    1. A cross-validation of the identified clusters will be conducted. Specifically, the repeated random sub-sampling validation approach will be used. Sub-sampling will be completed10 times, with each sub-sample representing the number of identified clusters multiplied by the minimum number of participants required per cluster. Split-half reliability will also be calculated.
    2. Note, if the clusters are not deemed to be reliable a different number of clusters will be identified and reliability calculated using the same approaches outlined above. For example, if 6 clusters are initially identified and are not reliable, 5 and 7 cluster solutions as outlined in step 5ai. will be evaluated for reliability.

5.2 Specific Aim 2:

Subject Population

1. Inclusion Criteria
    a. CCSS survivors who completed the Health Care Needs Survey independently
2. Estimated Sample Size
    a. Estimated n = 975
3. Primary Predictors
    a. Chemotherapy (yes/no)
    b. Radiation therapy
        i. Cranial (no, < 18GY, $\underline{\geq}$18Gy)
        ii. Other body (yes, no)
    c. Surgery (yes/no)
    d. Age at diagnosis
4. Covariates
    a. Age (current)
    b. Gender
    c. Race/ethnicity
    d. Health Insurance (2000 Follow-up question 16)
    e. Employment Status (2000 Follow-up question 3b)
    f. Educational Attainment (2000 Follow-up question 1)

        i. High school graduate or less
        ii. Some college or vocational training
        iii. College graduate
    g. Marital Status (2000 Follow-up question 2b)
        i. Single, never married
        ii. Married or living as married
        iii. Divorced or separated or no longer living as married
5. Outcome Measures
    a. Health Locus of control classes identified in Aim 1
6. Statistics- A polytomous logistic regression models will be performed to determine whether disease and treatment variables predict group membership clusters identified in Aim 1 that have sufficient sample size. The possibility of conducting several separate logistic regression models (i.e., evaluate each cluster separately) will be explored based on the interpretability of the polytomous regression results. We will also provide a figure showing the variability in patterns of individuals within each class to illustrate how well the class structure fits. This will provide evidence that the class grouping does not simply represent an average, but is actually representative of the majority of subjects in the class.

5.3 Specific Aim 3:

Subject Population

1. Inclusion Criteria
    a. CCSS survivors who were able to complete the Health Care Needs Survey independently
    b. CCSS survivors who completed the Follow-up 2003 questionnaire
2. Exclusion Criteria
    a. CCSS survivors who did not complete both the Health Care Needs Survey and the Follow-up 2003 questionnaire
3. Sample Size
    a. n = 867
4. Primary Predictors
    a. Health Locus of control (statistical approach 1)
        i. Classes of locus of control styles identified in Aim 1
    b. Health Locus of control (statistical approach 2)
        i. Raw scores on the Internal, Chance and Powerful Others Scales
5. Covariates (will depend on the results from Aim 2; predictors and covariates determined to be related to locus of control styles in Aim 2 will be included as covariates)
    a. Chemotherapy (yes/no)
    b. Radiation (cranial, other, none)
    c. Age at cancer diagnosis
    d. Age (current)
    e. Gender
6. Outcome Measures- Health Behaviors

a. BMI (Follow-up 2003 Questions 7 and 8)
    i. Yes = obese, overweight
    ii. No = normal, underweight
b. Monthly physical exercise (Follow-up 2003 D.1)
    i. Yes/no CDC Guidelines
c. Sunscreen use (Follow-up 2003 C.11a)
    i. Yes = often and always
    ii. No = never, rarely, sometimes
d. Current Smoking (Follow-up 2003 L.2)
    i. Yes/no

7. Outcome Measures- Healthcare Utilization
    a. Level of medical care with physicians (Follow-up 2003 A.1, A.5, A.8a)
        i. No healthcare (response of 'none' on question A.1)
        ii. General healthcare (response of 'physician' or 'nurse' on question A.1 and response of 'none' on question A.5)
        iii. General survivor care (response of 'physician' or 'nurse' on question A.1 and response of at least '1-2 times' on question A.5 and response of 'no' on question A.8a and a response of 'no' on question A.8b)
        iv. Risk-based survivor care (response of 'physician' or 'nurse' on question A.1 and response of at least '1-2 times' on question A.5 and response of 'yes' on either question A.8a or question A.8b)
    b. Routine dental care (Follow-up 2003 O.17)
        i. Yes
        ii. No = No, I don't know
8. Statistics- This aim will be evaluated using two different approaches: 1) Logistic regression analyses will be performed to determine whether clusters identified in Aim one predict health behaviors (BMI, physical exercise, sunscreen use and smoking) and healthcare utilization. 2) Logistic regression analyses will be performed to determine whether raw scores on each of the Health Locus of Control Scales (Internal, Chance, Powerful Others) predict health behaviors and healthcare utilization.

Table 1. Characteristics of participants who completed the following surveys: 1) Health Care Needs Survey, 2) 2003-Follow-up Survey and 3) Health Care Needs and 2003-Follow-up Surveys

	Health Care Needs Survey (HCN)		CCSS-Follow-up 2003 Survey		Both HCN & 2003	
	N	%	N	%	N	%
Gender						
Male	460	47	4764	51	399	46
Female	518	53	4667	49	468	54
Race/ethnicity						
White, non-Hispanic	741	76	8479	90	659	76
Minorities	229		903		200	
unknown	8		49		8	
Age at time of Survey						
17-29 yrs.	490	50	4093	43		
30-39 yrs.	365	37	3832	41		
40-54 yrs.	123	13	1506	16		
Cancer Diagnosis						
Leukemia	337	34	3203	34	293	34
CNS tumor	88	9	1184	13	77	9
Hodgkin lymphoma	157	16	1229	13	135	16
Non-Hodgkin's lymphoma	100	10	706	7	86	10
Neuroblastoma	82	8	871	9	74	9
Wilms Tumor	39	4	635	7	34	4
Soft tissue sarcoma	84	9	829	9	82	9
Bone tumor	91	9	774	8	86	10
Age at cancer diagnosis						
0-9 yrs.	554	57	5918	63	484	56
10-20 yrs.	424	43	3513	37	383	44
Cancer therapy						
Chemotherapy-Any	747	76	6796	72	665	78
Alkylating agents	538	55	4435	47	485	56
Anthracyclines	415	42	3399	36	375	43
Radiation therapy-Any	614	63	5662	60	547	63
Cranial irradiation	260	27	2768	29	227	26
Chest irradiation	194	20	1731	18	175	20

Table 2. Additional Demographic Characteristics

Variable	N	%
Health Insurance Yes No		
Employment Status Yes No		
Marital Status Single, never married Married or living as married Divorced or separated or no longer living as married		

Table 3. Additional Disease and Treatment Characteristics

Variable	N	%
Chemotherapy Yes No		
Cranial Radiation therapy No <20Gy ≥20Gy		
Other Bodily Radiation Yes No		
Surgery Yes No		

Table 4. Initial cluster centers for locus of control styles

	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Cluster 6	Cluster 7
	M (SD)	M (SD)	M (SD)	M (SD)	M (SD)	M (SD)	M (SD)
Internal							
Chance							
Powerful Others							

Table 5. Iteration history: Change in cluster centers

		Change in Cluster Centers						
		1	2	3	4	5	6	7
Iteration	1							
	2							
	3							
	X							

Table 6. Final cluster centers for locus of control styles

	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Cluster 6	Cluster 7
	M (SD)	M (SD)	M (SD)	M (SD)	M (SD)	M (SD)	M (SD)
Internal							
Chance							
Powerful Others							

Table 7. Number of cases in each cluster

	N	%
Cluster 1		
Cluster 2		
Cluster 3		
Cluster 4		
Cluster 5		
Cluster 6		
Cluster 7		

Table 8. Polytomous logistic regression models predicting patterns of locus of control

	Cluster 1	Cluster 2	Cluster 3	Cluster X
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Sex Female Male				
Age current				
Race/ethnicity White, non-Hispanic Minorities				
Health Insurance Yes No				
Employment Status Yes No				
Educational Attainment High school graduate or less Some college or vocational training College graduate				
Marital Status Single, never married Married or living as married Divorced or separated or no longer living as married				
Age at Diagnosis (years) 0-9 10-20				
Chemotherapy Yes No				
Cranial Radiation Therapy No <20Gy ≥20Gy				
Other bodily radiation Yes No				
Surgery Yes No				

Table 9. Logistic regression model: Identified clusters predicting health behaviors

	BMI	Monthly Physical Exercise	Smoking	Sunscreen use
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Cluster 1				
Cluster 2				
Cluster 3				
Cluster X				

+Treatment and demographic variables will be included in this model based on their contribution to each cluster and the known impact of such characteristics on health behaviors

Table 10. Logistic regression model: Raw scale scores predicting health behaviors

	BMI*	Monthly Physical Exercise*	Smoking*	Sunscreen use**	Alcohol Use***
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Internal (raw scale score)					
Chance (raw scale score)					
Powerful Others (raw scale score)					

Table 11. Multivariable regression models predicting healthcare utilization

	Level of medical care with physicians*	Routine dental care*
	OR (95% CI)	OR (95% CI)
Cluster 1		
Cluster 2		
Cluster 3		
Cluster X		

+Treatment and demographic variables will be included in this model based on their contribution to each cluster and the known impact of such characteristics on health behaviors
*Data from Follow-up survey 2003 and 2007

Table 12. Logistic regression model: Raw scale scores predicting healthcare utilization

	Level of medical care with physicians*	Routine dental care*
	OR (95% CI)	OR (95% CI)
Cluster 1		
Cluster 2		
Cluster 3		
Cluster X		

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