**Title:** Predictors of stage of adoption of screening mammography in childhood cancer survivors at increase risk of breast cancer

**Working group and investigators:**
This study will be conducted within the cancer control working group, primarily using data from the Mammogram Practices Survey (MPS).

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## 1. Background

Female survivors of childhood cancer who received chest radiation are at increased risk for breast cancer. Therefore, current screening guidelines for these survivors recommend an annual mammogram and breast MRI for women over 25 years of age or beginning 8 years following treatment (whichever occurs last), thus representing intense surveillance that is not typical for the general population.[12] Despite this recommendation, it has been shown that survivors of childhood cancer treated with chest radiation have low rates of mammography screening, with most nonadherence occurring in women under the age of 40.[3]

A prior CCSS study explored the relationship between general perceptions of mammography and mammography practices according to the transtheoretical model of stages of change in female survivors of childhood cancer who received chest radiation.[4] Findings revealed a significant discrepancy between perceptions of mammography and current stage of mammography practices, indicating that there are several additional factors that influence actual behaviors. The role of perceived risk of breast cancer and other variables in predicting current stage of adoption of mammography practice for long-term survivors of childhood cancer remains unknown.

The transtheoretical model (TTM) is used to describe health behaviors and current practices

and future intention for behavior change. [5,6] It includes 5 stages characterized by complete avoidance to complete adoption. Knowing the stage of adoption of a patient with regards to a desired health behavior has clinical implications for tailoring interventions and communication to promote adoption and maintenance of such health behaviors. [7-9] For example in low-income African American women, the transtheoretical model has been used to develop interventions aimed at increasing screening rates specifically for this at risk group. [10] Furthermore, understanding predictors of a particular stage of adoption (e.g., current mammography practice) can inform targets of intervention to promote adoption of desired behaviors.

Particular stages of adoption for mammography practices include: (I) Pre-contemplation (women who have never had a prior mammogram and are not planning to get a mammogram in the coming two years), (II) Contemplation (women who are planning to get a mammogram in the coming two years, but have not yet done so), (III) Action (women who have had a mammogram in the past two years and intend to have another one in the coming two years), (IV) Maintenance (women who have two or more mammograms in the past four years and intend to have another one in the coming two years) and (V) Relapse (women who have had one or more mammograms but don't intend to have another one in the coming year) (see table 1). [6] To date, there has been research showing that demographic variables (such as age, gender, race/ethnicity, level of education, income, other chronic medical problems) and psychosocial variables (such as self efficacy, knowledge, psychosocial stress and support) may predict later stages of change for mammography and other health promoting behaviors in the general population and at risk groups of women. [11-14] However, no study has extensively explored predictors of stage of mammography practices in survivors of childhood cancer. This is critical as women who receive chest RT are not at later stages of adoption than healthy controls despite their increased risk of breast cancer and recommendations for screening mammography at an earlier age than the general population (see table 2).

**Significance and Innovation**

Because of the limited understanding of predictors of mammography practices for long term survivors of childhood cancer at increased risk of breast cancer because of chest radiation, the proposed study aims to describe predictors of stage of adoption of mammography screening. We propose to evaluate demographic, disease/treatment related and psychosocial variables. Knowing how predictors of mammography practice vary according to the stages of adoption will inform the development of tailored approaches and interventions for this at-risk group.

**2. Aim**

This analysis will focus on women age 25 to 50 who were treated for childhood cancer with chest radiation (≥ 20 Gy) and therefore are at increased risk of breast cancer. These women should be undergoing yearly mammography for surveillance as per COG long-term follow up guidelines.

**Aim:** To identify demographic, treatment related and psychosocial factors associated with the stages of adoption of mammography practice for female survivors of childhood cancer at increased risk of breast cancer based on a history of chest radiation (chest RT).

## 3. Methods

**3.1 Study population:** Survivors who received chest radiation (≥ 20 Gy) and completed the Mammogram Practices Survey (MPS). (n=551).

**3.2 Study design:** This is a cross-sectional study, using data captured during a one-time survey of mammogram practices among the CCSS cohort. We will first assign women to each of the stages of adoption I-V (see table 1).

**3.3 Variables assessed:** Variables previously collected via the MPS will be used in this analysis. Additional variables of interest will be linked from data collected from other CCSS questionnaires will also be tested as predictors. For each linked variable not captured on the MPS, we will ideally use data from the CCSS 2003 Follow Up Survey. The 2003 survey was completed prior to the distribution of the MPS and thus would be most appropriate to collect variables to be used as predictors for mammography practice outcomes.

Demographic variables analyzed will include age at time of study, living area and parity information. Demographic variables included from the 2003 follow up survey will include education, insurance status and household income (see table 3).

Disease and treatment related variables include age at diagnosis, co-morbid conditions, physician recommendation and family history of breast cancer (see table 3).

The psychosocial variables will include perception of breast cancer risk as defined by an item on the MPS that asks women to rate their own risk of developing breast cancer as compared to healthy adult women and health locus of control concerning the extent to which a person believes they control their own health. Mother's history of screening mammography will also be analyzed as per the MPS. Coping strategies will be assessed via items from the COPE inventory included in the MPS. Health locus of control will be assessed based on items from the Wallston Multidimensional Health Locus of Control scale included in the MPS.

## 3.4 Statistical analysis:

The distribution of women with a history of chest radiation across the stages of adoption will be summarized (similar to Table 2a below). This may be done separately by one or two key characteristics (which might be demographic variables such as age at time of study, treatment related or psychosocial), and depending on the data selected factors of interest may be summarized within each stage of adoption (see Table 2b below). To formally assess which factors are associated with stages of adoption we will use regression methods for multinomial response data. Stages of adoption is an ordinal response variable and our intent is to primarily use a proportional odds model for this purpose. This model uses the logit of the cumulative probabilities and assumes that each predictor has an identical effect on each of the cumulative

probabilities. We will assess whether this model is a good fit for the data through several different methods including comparing observed and expected frequencies with a chi-squared statistic and graphical methods for evaluating the proportional odds assumption.

## 4. Tables

**Table 1. Stage of adoption of mammography practice**

| Stage of change | Mammography practice (as defined by MPS items) |
|---|---|
| I Pre- contemplation | Women who have never had a prior mammogram and are not planning to get a mammogram in the coming two years |
| II Contemplation | Women who are planning to get a mammogram in the coming two years, but have not yet done so |
| III Action | Women who have had a mammogram in the past two years and intend to have another one in the coming two years |
| IV Maintenance | Women who have two or more mammograms in the past four years and intend to have another one in the coming two years |
| V Relapse | Women who have had one or more mammograms but don't intend to have another one in the coming year |

**Table 2a. Distribution of patients across stages of change of mammography adoption**

| Stage of Adoption | Chest RT Age 25-39 years (n=303) n    % | Chest RT Age 40-52 years (n=280) n    % | No Chest RT Age 40-52 years (n=265) n    % | Sibling Control Age 40-52 years (n=297) n    % |
|---|---|---|---|---|
| I. Pre-contemplation | | | | |
| II. Contemplation | | | | |
| III. Action | | | | |
| IV. Maintenance | | | | |
| V. Relapse | | | | |

**Table 2b. Distribution of patients across stages of change of mammography adoption with covariate information**

| Stage of Adoption | Chest RT Age 25-39 years (n=303) n    % | Chest RT Age 40-52 years (n=280) n    % | No Chest RT Age 40-52 years (n=265) n    % | Sibling Control Age 40-52 years (n=297) n    % |
|---|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| I. Pre-contemplation<br>　Characteristic A<br>　Characteristic B | | | | |
| II. Contemplation<br>　Characteristic A<br>　Characteristic B | | | | |
| III. Action<br>　Characteristic A<br>　Characteristic B | | | | |
| IV. Maintenance<br>　Characteristic A<br>　Characteristic B | | | | |
| V. Relapse<br>　Characteristic A<br>　Characteristic B | | | | |

**Table 3. Covariates to be assessed**

| Variable Category | Variables |
|---|---|
| I. Demographic | Age at study (MPS)<br>Race (2003)<br>Household income (2003 S1)<br>Insurance status (2003 M1)<br>Insurance barrier^<br>Living area (urban/rural) (MPS)<br>Education (2003 Item 1)<br>Marital status (2003 Item 2)<br>Parity (MPS 25) |
| II. Disease/Treatment Related | Age at diagnosis<br>Knowledge of risk of breast cancer (MPS p6 Item 8)[@]<br>Family history of breast cancer (MPS HC Item 7)<br>Presence of chronic health conditions[#]<br>Physician recommendation (MPS Item 18) |
| III. Psychosocial | Perception of breast cancer risk (MPS Beliefs Item 9)[&]<br>Mother's history of screening mammography (MPS)<br>Coping strategies MPS (MPS p. 7)[#]<br>Health locus of control (MPS Wallston instrument)[*] |

[^] MPS Item 8 and Item 16
[@] Participants will be considered to have correct breast cancer knowledge if they responded "true" to the statement: "Women who were treated with radiation to the chest or breast area for childhood cancer are more likely to get breast cancer." Participants who responded "false" or

"not sure" will be considered to have incorrect knowledge.

\# Chronic health conditions will be dichotomized into presence or absence and will be assessed based on the presence or absence of grade 3 or 4 (severe, life-threatening, or disabling) chronic health conditions in MPS participants at the time of completion of study. The measured grade 3 and 4 chronic health conditions are a composite from previous CCSS surveys (as per Armstrong et al. Aging and Risk of Severe, Disabling, Life-Threatening, And Fatal Events in the Childhood Cancer Survivor Study' JCO March 2014).

& Perception of risk of breast cancer will be dichotomized into increased risk or no increased risk based on response with increased risk defined as respondents answering they are at "much more" or "more" risk than the average women for breast cancer and no increased risk being defined as respondents answering they have risk for breast cancer that is the "same", "less than" and "much less than" the average women.

\# Coping will be measured by six scales from the COPE inventory, completed with reference to how participants generally cope with stressful experiences: behavioral disengagement, mental disengagement, denial, acceptance, active coping, and planning coping.

\* Perceived health locus of control will be measured using the Wallston Multidimensional Health Locus of Control scales. Three independent domains describe an individual's perception of the extent to which she controls her health: internal ("I am in control"), chance ("what will be will be") and powerful others ("health professionals control my health).

Table 4. Demographic characteristics

| Variable | Category | n | % |
|---|---|---|---|
| Age | 25-29<br>30-34<br>35-39<br>40-44<br>45-50 | | |
| 2. Race | Categorical | | |
| 3. Household income | Categorical | | |
| 4. Insurance status | Insured<br>Uninsured | | |
| 5. Living area | Urban<br>Rural | | |
| 6.Education | Some High school<br>High school graduate<br>College or professional training | | |
| 7. Marital status | Unmarried<br>Married | | |
| 8. Parity | Nulliparous<br>Primiparous or multiparous | | |

Table 5. Disease related characteristics

| Characteristic | Category | n | % |
|---|---|---|---|
| Age at diagnosis | <5 years<br>5-10 years<br>11-15 years<br>16+ years | | |
| Knowledge of risk of breast cancer | Positive<br>Negative | | |
| Family history of breast cancer | Positive<br>Negative | | |
| Presence of chronic health conditions | Present<br>Absent | | |
| Physician Recommendation | Present<br>Absent | | |

## Table 6. Psychosocial Measures

| Measure | Category | n | % |
|---|---|---|---|
| Perceived breast cancer risk | Increased risk<br>No increased risk | | |
| Mother's history of screening mammography | Positive<br>Negative | | |
| Coping strategy | Behavioral disengagement<br>Mental disengagement<br>Denial<br>Acceptance<br>Active coping<br>Planning coping | | |
| Health locus of control | Internal<br>Chance<br>Powerful others | | |

## Table 7. Demographic characteristics and stage of adoption

| Variable | Category | Stage I OR p-value | Stage II OR p-value | Stage III OR p-value | Stage IV OR p-value | Stage V OR p-value |
|---|---|---|---|---|---|---|
| Age | 25-29<br>30-34<br>35-39<br>40-44<br>45-50 | | | | | |
| Race | Categorical | | | | | |
| Household income | Categorical | | | | | |
| Insurance status | Uninsured<br>Insured | | | | | |
| Living area | Urban<br>Rural | | | | | |
| Education | Some High | | | | | |

| | | Stage I OR p-value | Stage II OR p-value | Stage III OR p-value | Stage IV OR p-value | Stage V OR p-value |
|---|---|---|---|---|---|---|
| | school High school graduate College or professional training | | | | | |
| Marital status | Unmarried Married | | | | | |
| Parity | Nulliparous Primiparous or multiparous | | | | | |

Table 8. Disease Related Characteristics and Stage of Adoption

| Characteristic | Category | Stage I OR p-value | Stage II OR p-value | Stage III OR p-value | Stage IV OR p-value | Stage V OR p-value |
|---|---|---|---|---|---|---|
| Age at diagnosis | <5 years 5-10 years 11-15 years 16+ years | | | | | |
| Knowledge of risk of breast cancer | Positive Negative | | | | | |
| Family history of breast cancer | Positive Negative | | | | | |
| Chronic health conditions | Present Absent | | | | | |
| Physician Recommendation | Present Absent | | | | | |

Table 9. Psychosocial Measures and Stage of Adoption

| Measure | Category | Stage I OR p-value | Stage II OR p-value | Stage III OR p-value | Stage IV OR p-value | Stage V OR p-value |
|---|---|---|---|---|---|---|
| Perceived breast cancer risk | Increased risk No increased risk | | | | | |
| Mother's history of screening mammography | Positive Negative | | | | | |
| Coping strategy | Behavioral disengagement Mental disengagement Denial Acceptance Active coping Planning coping | | | | | |
| Health locus of control | Internal Chance Powerful others | | | | | |

References

1. Landier W, Bhatia S, Eshelman DA, et al. Development of risk-based guidelines for pediatric cancer survivors: the Children's Oncology Group long-term follow-up guidelines from the Children's Oncology Group late effects committee and nursing discipline. J Clin Oncol 2004;22(24):4979–4990.
2. Children's Oncology Group; 2007. Long-Term Follow-Up Guidelines for Survivors of Childhood, Adolescent, and Young Adult Cancers. Updated October 2008; Available from: www.survivorshipguidelines.org
3. Oeffinger KC, Ford JS, Moskowitz CS, et al. Breast cancer surveillance practices among women previously treated with chest radiation for a childhood cancer. JAMA 2009;301(4):404–414.
4. Smith SM, Ford JS, Rakowski W et al. Inconsistent mammogram perceptions and practices among women at risk of breast cancer following a pediatric malignancy: a report from the Childhood Cancer Survivorship Study. Cancer Causes Control. 2010 October; 21(10):1585-1595.
5. Prochaska JO, DiClemente, CC. The transtheoretical approach. Norcross, JC; Goldfried, MR. (eds.) Handbook of psychotherapy integration. 2nd ed. New York: Oxford University Press; 2005: 147–171.
6. Rakowski W, Dube C, Goldstein M. Considerations for extending the transtheoretical model of behavior change to screening mammography. Health Educ Res. 1996;11:77–96.
7. Spencer L, Pagell F, Adams T. Applying the Transtheoretical Model to Cancer Screening Behavior. Am J Health Behavior. 2005;29(l):36-56
8. Ryan GL. Skinner CS, Farrell D, Champion VL. Examining the boundaries of tailoring: the untility of tailoring versus targeting mammography interventions for two distinct populations. Health Educ Res 2001. Oct16(5):555-66.
9. Champion VL, Menon U, Maraj M, et al. Comparison of tailored interventions to increase mammography screening in nonadherent older women. Prev Med 2003;36:150–158.
10. Champion VL. Springston JK Zollinger TW et al. Comparison of three interventions to increase mammography screening in low income African American women. Cancer Detect Prev 2006:30(6):535-44.
11. Choi JH, Chung KM, Park K. Psychosocial predictors of four health-promoting behaviors for cancer prevention using the stage of change of Transtheoretical Model. Pyscho-Oncology 2013;22:2253-2261.
12. Beydoun HA, Beydoun MA. Predictors of colorectal cancer screening behaviors among average-risk older adults in the United States. Cancer Causes Control 2008;19(4):339–359. 44.
13. Moodi M, Rezaelan M, Mostafavi F, Sharifirad GR. Mammography stage of adoption among Iranian women. J Educ Health Promot. 2012; 1:37.
14. Chamot et al. Predicting stages of adoption of mammography screening in a general population. European Journal of Cancer 37(2001)1869-1877.