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Screening and Surveillance for Second Malignant Neoplasms in Adult Survivors of Childhood Cancer: A Report From the Childhood Cancer Survivor Study

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Background: Survivors of childhood cancer may develop a second malignant neoplasm during adulthood and therefore require regular surveillance.

Objective: To examine adherence to population cancer screening guidelines by survivors at average risk for a second malignant neoplasm and adherence to cancer surveillance guidelines by survivors at high risk for a second malignant neoplasm.

Design: Retrospective cohort study.

Setting: The Childhood Cancer Survivor Study (CCSS), a 26-center study of long-term survivors of childhood cancer that was diagnosed between 1970 and 1986.

Patients: 4329 male and 4018 female survivors of childhood cancer who completed a CCSS questionnaire assessing screening and surveillance for new cases of cancer.

Measurements: Patient-reported receipt and timing of mammography, Papanicolaou smear, colonoscopy, or skin examination was categorized as adherent to the U.S. Preventive Services Task Force guidelines for survivors at average risk for breast or cervical cancer or the Children's Oncology Group guidelines for survivors at high risk for breast, colorectal, or skin cancer as a result of cancer therapy.

Results: In average-risk female survivors, 2743 of 3392 (80.9%) reported having a Papanicolaou smear within the recommended period, and 140 of 209 (67.0%) reported mammography within the recommended period. In high-risk survivors, rates of recommended mammography among women were only 241 of 522 (46.2%) and the rates of colonoscopy and complete skin examinations among both sexes were 91 of 794 (11.5%) and 1290 of 4850 (26.6%), respectively.

Limitations: Data were self-reported. Participants in the CCSS are a selected group of survivors, and their adherence may not be representative of all survivors of childhood cancer.

Conclusion: Female survivors at average risk for a second malignant neoplasm show reasonable rates of screening for cervical and breast cancer. However, surveillance for new cases of cancer is very low in survivors at the highest risk for colon, breast, or skin cancer, suggesting that survivors and their physicians need education about their risks and recommended surveillance.

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More than 325 000 persons who had childhood cancer are alive in the United States (1); many of these survivors are at increased risk for a second malignant neoplasm as a result of the therapy for their primary cancer (2–5). Almost 10% of survivors develop a second malignant neoplasm within 30 years of the initial cancer diagnosis (2), and new malignant conditions are the most frequent cause of late mortality in patients who survive for more than 20 years after their childhood cancer is diagnosed (6, 7). Among survivors of childhood cancer who are not considered to be at increased risk for a specific second malignant neoplasm (average-risk survivors), adherence to cancer screening guidelines directed at the general population is particularly important. These screening guidelines are published by such organizations as the U.S. Preventive Services Task Force (USPSTF), the Canadian Task Force on Preventive Health Care, and the American Cancer Society. Because many children with cancer receive intensive chemotherapy or radiation, their options for therapy may be limited if they develop a second malignant neoplasm later in life. For example, a female survivor who develops invasive node-positive breast cancer during adulthood may not be able to receive adjuvant doxorubicin if she had anthracycline chemotherapy for her childhood cancer (8). Adherence to recommended screening for breast or cervical cancer in adult survivors of childhood cancer who are at average risk may lead to earlier detection and reduced morbidity or mortality and is therefore imperative.

The use of radiation therapy to treat childhood cancer has caused breast cancer (4, 5, 9, 10), colorectal and other types of gastrointestinal cancer (5, 11–13), malignant melanoma (5, 14, 15), and nonmelanoma skin cancer (2, 16) to occur at a younger age and with increased frequency in survivors of childhood cancer than in the general popula-

See also:

Print
Editors' Notes 443
Summary for Patients I-42

Web-Only
Appendix Table
Appendix Figure
Conversion of graphics into slides

tion. Studies of other populations at increased risk for one of these neoplasms (17–22) have shown that more intense surveillance beginning at an earlier age than is recommended for the general population may lead to improved outcome in high-risk persons. Consequently, the Children's Oncology Group (COG) (23, 24) and other national and international groups (25–27) have written consensus-based guidelines for lifelong surveillance for second malignant neoplasms in survivors of childhood cancer who are at increased risk for a therapy-related malignant condition.

To evaluate adherence to recommended screening and surveillance in survivors of childhood cancer at average or high risk for a second malignant neoplasm during adulthood, we assessed these health practices in the Childhood Cancer Survivor Study (CCSS) cohort. We evaluated adherence to population screening guidelines in female survivors at average risk for breast or cervical cancer. In addition, we examined adherence to cancer surveillance guidelines in survivors at high risk for breast, colorectal, or skin cancer as a result of cancer therapy.

Context

The Children's Oncology Group developed guidelines for screening survivors of childhood cancer whose treatments put them at elevated risk for breast, colorectal, and skin cancer.

Contribution

This survey of more than 8000 survivors of childhood cancer found that most patients who were eligible for breast, colorectal, and skin cancer screening did not report receipt of screening within the recommended interval. Reported screening rates were worst for colorectal cancer (11.5%), followed by skin cancer (26.6%) and breast cancer (46.2%).

Caution

Screening rates were based on patient self-report.

Implication

Survivors of childhood cancer and their physicians must be better educated about the potential benefits of enhanced cancer screening.

—The Editors

METHODS

Childhood Cancer Survivor Study

The CCSS methodology and a description of the participants have been published elsewhere (28–30). In brief, the cohort includes persons who received cancer diagnoses before age 21 years at 1 of 26 centers (25 in the United States and 1 in Canada) from 1970 to 1986 and who were alive at least 5 years from their original diagnosis. The eligible cohort consisted of 20 626 participants, of whom 17 568 (85.2%) were successfully contacted and 14 357 (69.6%) enrolled in the study. Sex, age at diagnosis, cancer type, or treatment did not differ significantly between participants and nonparticipants (28, 31). Detailed diagnosis and treatment information were abstracted systematically from participants' hospital records. Participants completed a comprehensive baseline questionnaire and several subsequent questionnaires. Eligibility for this analysis was limited to the 8347 participants who completed a questionnaire in 2002 to 2003 (hereafter referred to as the "CCSS 2003 questionnaire") that addressed cancer screening and surveillance practices and who had not developed a new neoplasm before completing the questionnaire (**Appendix Figure**, available at www.annals.org). Study instruments are available at http://ccss.stjude.org. The study was approved by institutional review boards at each participating institution, and informed consent was obtained from each participant.

Cancer Screening in Average-Risk Female Survivors

We examined adherence of female survivors to the USPSTF cervical and breast cancer screening recommendations for the general (average-risk) population (**Appendix Table**, available at www.annals.org) (32). We used the guidelines that were current at the time of the survey (the 2002 breast cancer guidelines and the 2003 cervical cancer guidelines). The survey questions were designed to mirror those used on the 2003 National Health Interview Survey (33). The USPSTF recommends screening for cervical cancer with a Papanicolaou smear every 3 years starting at the time of first sexual intercourse or age 21 years, whichever is earlier. Because time of first intercourse was not captured by the study questionnaire, we used age 21 years as the expected time of commencement of screening. At the time of the questionnaire, the USPSTF recommended mammography every 1 to 2 years in all women aged 40 years or older.

For each screening test, we classified survivors as completing the test within the recommended period; completing the test but not within the recommended period; or never having completed the test. Only survivors who completed the test within the recommended period were considered to be "adherent" to the guidelines. For example, to assess adherence with mammography screening recommendations, we asked female respondents, "When was the last time you had a mammogram?" and gave them 6 options: never, less than 1 year ago, 1 to 2 years ago, more than 2 years but less than 5 years ago, 5 or more years ago, or don't know. Women aged 42 years or older (allowing for 2 years from their 40th birthday) who reported mammography "less than 1 year ago" or "1 to 2 years ago" were considered adherent to the guidelines. We excluded Canadian survivors from the breast cancer screening analysis because that country's guidelines suggest mammography starting at age 50 years (34) rather than age 40 years, as was suggested by the USPSTF at the time of the questionnaire.

In addition, survivors who were classified as having a high risk for breast cancer were excluded from this analysis of breast cancer screening in average-risk persons and are included in the analysis of breast cancer surveillance in high-risk persons.

Cancer Surveillance in Female Survivors at High Risk for Breast Cancer and in Male and Female Survivors at High Risk for Colorectal Cancer, Malignant Melanoma, or Nonmelanoma Skin Cancer

We assessed adherence to the COG Long-Term Follow-Up Guidelines for Survivors of Childhood, Adolescent, and Young Adult Cancers (23) in all survivors considered to be at increased risk for breast, colorectal, or skin cancer (malignant melanoma or nonmelanoma skin cancer) as a result of their cancer therapy (**Appendix Table**). The COG defines women at high risk for breast cancer as those who received radiation therapy of 20 Gy or more to the chest and recommends annual mammography beginning 8 years after radiation or at age 25 years, whichever occurs last. Survivors are considered to be at high risk for colorectal cancer if they received radiation therapy of 30 Gy or more to the abdomen, pelvis, or spine. The COG recommends colonoscopy every 5 years starting at age 35 years for these survivors. Finally, survivors are considered at high risk for skin cancer if they had any radiation therapy, and annual dermatologic examination of all irradiated areas is recommended.

Predictors of Screening and Surveillance

Demographic data were obtained on the baseline questionnaire. Sociodemographic status (marital status, health insurance, and education) was assessed in the CCSS 2003 questionnaire. Disease and treatment variables were abstracted from medical records. To evaluate the association among health status, chronic medical conditions, and surveillance and screening, we classified the severity of chronic health conditions reported on the baseline questionnaire as none (0); mild (1); moderate (2); severe (3); or life-threatening or disabling (4) by using the National Cancer Institute's Common Terminology Criteria for Adverse Events (version 3) (35). We measured health status by using a previously defined set of domains (emotional health, physical function, cancer-related pain, and cancer-related anxiety and fears) (36). Emotional health was assessed with the 18-item Brief Symptom Index and was classified as poor in patients scoring higher than 63 on this instrument's global status index (36, 37). Physical function was assessed with the role–physical subscale of the 36-item Short Form Health Survey (38) and was classified as poor in patients scoring less than 40. Cancer-related pain and anxiety were assessed separately on a 5-point Likert scale and were dichotomized into none or a small amount versus moderate, a lot, or extreme (36). To evaluate survivors' concerns regarding their future health, we asked them whether the statement, "I expect my health to get worse" was "definitely true," "mostly true," "mostly false," or "definitely false" and dichotomized their responses as "true" or "false."

Statistical Analysis

We calculated descriptive statistics, including frequencies, percentages, means, and SDs (as appropriate), for demographic characteristics, disease, and health status. We calculated the proportions of survivors in the average-risk and high-risk categories for second malignant neoplasms who adhered to the appropriate screening and surveillance guidelines and reported them as percentages. The relative risks for adherence to the guidelines were calculated by demographic and health status variables and compared in multiple variable regression models by using a log link and a Poisson distribution (39). Demographic, socioeconomic, health history, chronic disease, and health status predictors of participation in surveillance were evaluated in multiple variable models if they were independently associated with the outcome ($P < 0.100$). We evaluated independent variable collinearity by examining variance inflation factors and tolerance (40). Variables that were highly correlated were not included in the same models. Data analyses were completed by using SAS statistical software, version 9.2 (SAS Institute, Cary, North Carolina).

Role of the Funding Source

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RESULTS

Cohort Characteristics

Of the 9308 survivors who responded to the CCSS 2003 questionnaire, 961 were not eligible for this analysis. One survivor did not complete the baseline questionnaire, and 960 survivors had developed a second malignant neoplasm. Consequently, the total number of survivors was 8347 (4018 women and 4329 men). The mean age at diagnosis was 8.1 years (SD, 5.7) in men and 7.6 years (SD, 5.7) in women. The mean age at the time of questionnaire completion was 31.5 years (SD, 7.3) in men and 30.8 years (SD, 7.3) in women. **Table 1** presents demographic, treatment, and health status characteristics of the participants, stratified by sex.

Cancer Screening in Survivors at Average Risk for Cervical or Breast Cancer

The number of female survivors who were not at increased risk for cervical or breast cancer as a result of previous cancer therapy and who had reached the age at which screening of the general population is recommended was 3392 for Papanicolaou smear and 209 for mammography. Of these, 81% (2743 of 3392) reported a Papanicolaou smear within the recommended period, and 67.0% (140 of

Table 1. **Demographic, Disease, and Health Status Data**

Characteristic	Male Survivors (*n* = 4329), *n* (%)	Female Survivors (*n* = 4018), *n* (%)
Race/ethnicity		
Non-Hispanic white	3842 (88.7)	3536 (88.0)
Nonwhite	472 (10.9)	468 (11.6)
Not reported	15 (0.4)	14 (0.4)
Cancer diagnosis		
Leukemia	1441 (33.3)	1447 (36.0)
Central nervous system tumor	562 (13.0)	502 (12.5)
Hodgkin lymphoma	495 (11.4)	380 (9.4)
Non-Hodgkin lymphoma	452 (10.4)	199 (5.0)
Wilms tumor	371 (8.5)	465 (11.6)
Neuroblastoma	263 (6.1)	336 (8.4)
Soft-tissue sarcoma	393 (9.1)	346 (8.6)
Bone cancer	350 (8.1)	343 (8.5)
Unknown	2 (0.1)	–
Age		
<18 y	10 (0.2)	8 (0.2)
18–24 y	959 (22.2)	1033 (25.7)
25–34 y	1971 (45.5)	1827 (45.5)
≥35 y	1389 (32.1)	1150 (28.6)
Marital status		
Single, widowed, divorced, or separated	2421 (55.9)	2120 (52.7)
Married or living as married	1873 (43.3)	1859 (46.3)
Unknown	35 (0.8)	39 (1.0)
Education		
Post–high school or some college	1597 (36.9)	1469 (36.6)
High school or less	1015 (23.4)	806 (20.0)
College or higher	1674 (38.7)	1701 (42.3)
Unknown	43 (1.0)	42 (1.1)
Insurance status		
U.S. insured or Canadian	3683 (85.1)	3520 (87.6)
U.S. uninsured	603 (13.9)	470 (11.7)
Unknown	43 (1.0)	28 (0.7)
Concern about future health (expect worse)		
False	3153 (72.8)	3048 (75.8)
True	1145 (26.5)	959 (23.9)
Unknown	31 (0.7)	11 (0.3)
Chronic disease status*		
Grades 0, 1, 2	3449 (79.7)	3027 (75.3)
Grades 3, 4	880 (20.3)	991 (24.7)
Poor emotional health		
No	3586 (82.8)	3367 (83.8)
Yes	386 (8.9)	397 (9.9)
Unknown	357 (8.3)	254 (6.3)
Poor physical function		
No	3942 (91.1)	3492 (86.9)
Yes	369 (8.5)	505 (12.6)
Unknown	18 (0.4)	21 (0.5)
Cancer-related pain		
None or a small amount	3916 (90.5)	3564 (88.7)
Moderate, a lot, or extreme	381 (8.8)	439 (10.9)
Unknown	32 (0.7)	15 (0.4)
Survivor has cancer treatment summary		
No	2711 (62.6)	2464 (61.3)
Yes	996 (23.0)	1058 (26.3)
Unknown	622 (14.4)	496 (12.4)
Received medical care at a cancer center in the past 2 y		
No	3827 (88.4)	3483 (86.7)
Yes	502 (11.6)	535 (13.3)
Cancer-related visit in past 2 y		
No	3049 (70.4)	2675 (66.6)
Yes	1170 (27.0)	1244 (31.0)
Unknown	110 (2.6)	99 (2.5)

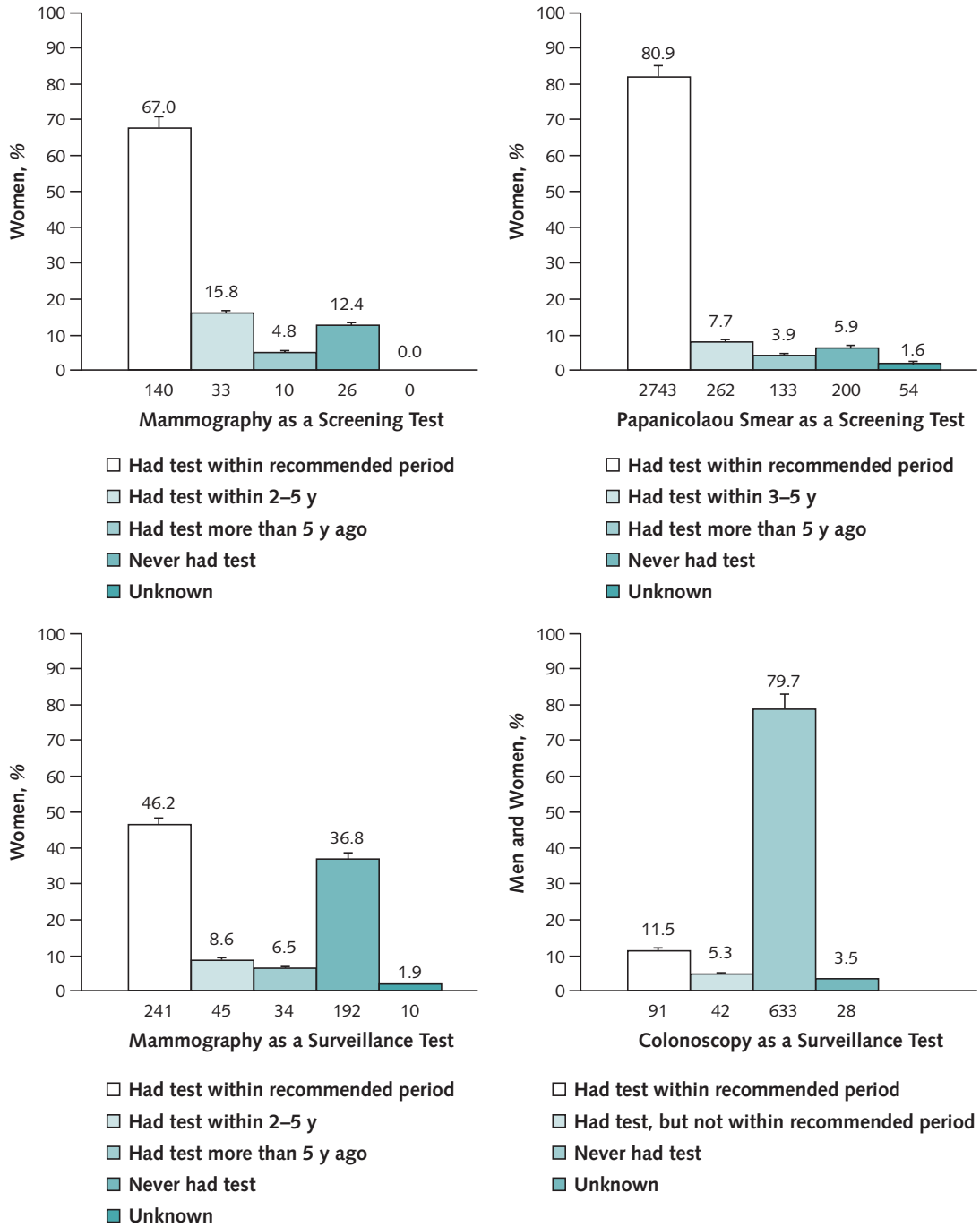
* According to the National Cancer Institute's Common Terminology Criteria for Adverse Events (version 3) grading, 0 = none, 1 = mild, 2 = moderate, 3 = severe, and 4 = life-threatening or disabling.

209) reported mammography within the recommended period (**Figure**). A total of 6% (200 of 3392) and 12.4% (26 of 209) of survivors reported never having had a Papanicolaou smear or mammography, respectively. **Table 2** lists the univariate and multivariate logistic regression models predicting adherence to mammography and Papanicolaou smear screening guidelines. Concern about future health, poor physical function, cancer-related pain, the survivor having a copy of their cancer treatment summary, medical care at a cancer center in the preceding 2 years, and a cancer-related visit in the preceding 2 years were not statistically significant in the univariate analysis for adherence to Papanicolaou smear or mammography and thus are not shown in the table. Being "married or living as married" (relative risk [RR], 1.15 [95% CI, 1.06 to 1.24]) was associated with an increased likelihood of Papanicolaou smear adherence, whereas having a high school education or less (RR, 0.87 [CI, 0.77 to 0.98]) or being uninsured (RR, 0.85 [CI, 0.74 to 0.97]) was associated with a decreased likelihood of adherence. No demographic, socioeconomic, or health status factors predicted adherence to mammography screening recommendations.

Cancer Surveillance in Survivors at High Risk for Breast, Colorectal, or Skin Cancer

In female survivors at increased risk for breast cancer and in survivors of both sexes at increased risk for colorectal cancer who required surveillance according to COG guidelines, only 241 of 522 (46.2%) and 91 of 794 (11.5%) reported having mammography or colonoscopy, respectively, within the recommended period (**Figure**). Only 1290 of 4850 survivors (26.6%) at increased risk for skin cancer reported ever having a complete examination of all irradiated areas. **Table 3** shows the univariate and multivariate logistic regression models predicting adherence to

Figure. **Adherence to screening guidelines for mammography and Papanicolaou smear by female survivors at average risk for breast or cervical cancer, and to surveillance guidelines for mammography (women only) and colonoscopy (both sexes) by survivors at increased risk for breast or colorectal cancer.**



surveillance guidelines for mammography, colonoscopy, and skin examination. Older age at interview (RR, 1.08 [CI, 1.05 to 1.11]) was associated with an increased likelihood of reporting mammography. Older age at interview (RR, 1.07 [CI, 1.02 to 1.12]), the survivor having a treatment summary (RR, 1.66 [CI, 1.06 to 2.61]), and a medical visit related to their previous cancer within the preceding 2 years (RR, 2.69 [CI, 1.62 to 4.47]) were associated with an increased likelihood of reporting colonoscopy. Having a college education or higher (RR, 1.24 [CI, 1.08

to 1.42]), receiving medical care at a cancer center within the preceding 2 years (RR, 1.43 [CI, 1.21 to 1.68]), and the survivor having a copy of the cancer treatment summary (RR, 1.31 [CI, 1.15 to 1.49]) were associated with an increased likelihood of reporting a skin examination. Survivors who were nonwhite (RR, 0.67 [CI, 0.52 to 0.86]), had moderate to extreme cancer-related pain (RR, 0.77 [CI, 0.62 to 0.95]) or had not had a medical visit related to their previous cancer within the preceding 2 years (RR, 0.84 [CI, 0.73 to 0.96]) were less likely to report a skin examination.

DISCUSSION

We assessed the cancer screening and surveillance practices of 8347 survivors of childhood cancer. It is encouraging that female survivors at average risk for cervical cancer or breast cancer had acceptable adherence to Papanicolaou smear and mammography recommendations, with rates of 81% and 67%, respectively. This suggests that female survivors of childhood cancer are generally health-conscious and aware of screening guidelines published for the general population. Adult survivors of cancer have been shown to have better adherence to cancer screening recommendations than that observed in the general population (41), although actual screening rates vary greatly and are often suboptimum.

Despite the relatively high screening rates for survivors at average risk for another case of cancer, the rates of surveillance for those at high risk for a therapy-related second malignant neoplasm were alarmingly low. Fewer than half of the survivors at increased risk for breast, colorectal, or skin cancer reported adherence with recommended surveillance. Women who have had radiation therapy to the chest during childhood have a 13% to 20% cumulative incidence of breast cancer by age 40 to 45 years (42), a risk similar to that observed in women with breast cancer–susceptibility gene mutations (43–45). Several studies have recognized an emerging risk for colorectal cancer in patients who have had abdominal or pelvic radiation as part of their primary therapy, with a 3.9- to 4.7-fold increased risk compared with the general population (13, 14, 46). Increased rates of other gastrointestinal malignant condi-

Table 2. **Predictors of Adherence to Mammography and Papanicolaou Smear Guidelines in Female Survivors at Average Risk for Breast or Cervical Cancer***

Characteristic	Mammography (n = 209 women; 140 adherent)		Papanicolaou Smear (n = 3392 women; 2743 adherent)	
	Univariate RR (95% CI)	Multivariate RR (95% CI)†	Univariate RR (95% CI)	Multivariate RR (95% CI)†
Race				
White	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
Nonwhite	1.00 (0.55–1.80)	0.99 (0.54–1.81)	1.02 (0.91–1.15)	1.05 (0.94–1.19)
Age at interview	1.02 (0.95–1.10)	1.03 (0.95–1.11)	1.00 (1.00–1.01)	1.00 (0.99–1.01)
Marital status				
Single, widowed, divorced, or separated	1.00 (reference)		1.00 (reference)	1.00 (reference)
Married or living as married	1.14 (0.79–1.66)		1.17 (1.08–1.26)	1.15 (1.06–1.24)
Education				
Post–high school or some college	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
High school or less	1.06 (0.64–1.75)	1.04 (0.63–1.74)	0.84 (0.75–0.95)	0.87 (0.77–0.98)
College or higher	1.37 (0.92–2.02)	1.37 (0.92–2.03)	1.05 (0.97–1.14)	1.03 (0.95–1.12)
Insurance status				
U.S. insured or Canadian			1.00 (reference)	1.00 (reference)
U.S. uninsured			0.81 (0.71–0.92)	0.85 (0.74–0.97)
Chronic disease status‡				
Grades 0, 1, 2	1.00 (reference)		1.00 (reference)	
Grades 3, 4	1.06 (0.76–1.49)		0.97 (0.89–1.05)	
Poor emotional health				
No	1.00 (reference)		1.00 (reference)	1.00 (reference)
Yes	0.76 (0.46–1.26)		0.93 (0.81–1.06)	0.95 (0.85–1.08)

RR = relative risk.
* RR >1.00 indicates increased adherence to the recommended screening test, and RR <1.00 indicates decreased adherence.
† We performed univariate analysis and included all variables with a P value <0.10 in the multivariate model. We evaluated independent variable colinearity by examining variance inflation factors and tolerance. Variables that were highly correlated were not included in the same models. The multivariate analysis of mammography and Papanicolaou smear is adjusted for race, age at questionnaire, and age at diagnosis.
‡ According to the National Cancer Institute's Common Terminology Criteria for Adverse Events (version 3) grading, 0 = none, 1 = mild, 2 = moderate, 3 = severe, and 4 = life-threatening or disabling.

Table 3. **Predictors of Adherence to Mammography, Colonoscopy, and Skin Examination Guidelines in Survivors at High Risk for Breast, Colorectal, or Skin Cancer***

Characteristic	Mammography (n = 522 women; 241 adherent)		Colonoscopy (n = 794 men and women; 91 adherent)		Skin Examination (n = 4850 men and women; 1290 adherent)	
	Univariate RR (95% CI)	Multivariate RR (95% CI)†	Univariate RR (95% CI)	Multivariate RR (95% CI)†	Univariate RR (95% CI)	Multivariate RR (95% CI)†
Sex						
Female			1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
Male	NA	NA	1.00 (0.65–1.56)	0.79 (0.51–1.23)	1.14 (1.02–1.27)	1.08 (0.97–1.22)
Race						
White	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
Nonwhite	1.12 (0.73–1.72)	1.29 (0.81–2.04)	1.25 (0.63–2.46)	1.48 (0.78–2.80)	0.68 (0.55–0.84)	0.67 (0.52–0.86)
Age at interview	1.08 (1.06–1.10)	1.08 (1.05–1.11)	1.06 (1.03–1.10)	1.07 (1.02–1.12)	1.01 (1.00–1.02)	1.01 (1.00–1.03)
Marital status						
Single, widowed, divorced, or separated	1.00 (reference)	1.00 (reference)	1.00 (reference)		1.00 (reference)	
Married or living as married	1.63 (1.23–2.16)	1.24 (0.92–1.66)	1.12 (0.72–1.74)		1.09 (0.98–1.22)	
Education						
Post–high school or some college	1.00 (reference)	1.00 (reference)	1.00 (reference)		1.00 (reference)	1.00 (reference)
High school or less	0.70 (0.46–1.07)	0.75 (0.48–1.15)	1.00 (0.53–1.90)		0.88 (0.75–1.03)	0.93 (0.77–1.12)
College or higher	1.00 (0.76–1.33)	0.98 (0.73–1.30)	1.04 (0.64–1.71)		1.28 (1.13–1.45)	1.24 (1.08–1.42)
Insurance status						
U.S. insured or Canadian	1.00 (reference)	1.00 (reference)	1.00 (reference)		1.00 (reference)	1.00 (reference)
U.S. uninsured	0.63 (0.35–1.16)	0.88 (0.47–1.64)	0.97 (0.47–2.01)		0.67 (0.56–0.82)	0.85 (0.69–1.06)
Concern about future health (expect worse)						
False	1.00 (reference)		1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
True	1.18 (0.89–1.57)		1.78 (1.13–2.80)	1.15 (0.72–1.83)	1.15 (1.02–1.30)	1.07 (0.92–1.23)
Chronic disease status‡						
Grades 0, 1, 2	1.00 (reference)		1.00 (reference)	1.00 (reference)	1.00 (reference)	
Grades 3, 4	1.10 (0.85–1.44)		1.63 (1.04–2.55)	1.28 (0.82–2.01)	1.09 (0.96–1.24)	
Poor emotional health						
No	1.00 (reference)		1.00 (reference)	1.00 (reference)	1.00 (reference)	
Yes	0.91 (0.60–1.38)		1.15 (1.07–1.24)	1.63 (0.91–2.92)	0.88 (0.72–1.08)	
Poor physical function						
No	1.00 (reference)		1.00 (reference)	1.00 (reference)	1.00 (reference)	
Yes	0.83 (0.56–1.23)		1.07 (1.01–1.14)	0.95 (0.53–1.69)	0.90 (0.75–1.08)	
Cancer-related pain						
None or a small amount	1.00 (reference)		1.00 (reference)		1.00 (reference)	1.00 (reference)
Moderate, a lot, or extreme	0.79 (0.51–1.22)		1.40 (0.79–2.48)		0.85 (0.70–1.03)	0.77 (0.62–0.95)
Survivor has cancer treatment summary						
No	1.00 (reference)		1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
Yes	1.04 (0.78–1.38)		1.84 (1.15–2.94)	1.66 (1.06–2.61)	1.40 (1.25–1.57)	1.31 (1.15–1.49)
Received medical care at a cancer center in the past 2 y						
No	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
Yes	1.51 (1.12–2.02)	1.35 (0.97–1.87)	1.68 (0.98–2.88)	1.08 (0.63–1.84)	1.64 (1.43–1.87)	1.43 (1.21–1.68)
Cancer-related visit in past 2 y						
Yes	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
No	0.72 (0.56–0.93)	0.79 (0.60–1.05)	0.33 (0.21–0.53)	0.37 (0.22–0.62)	0.70 (0.63–0.78)	0.84 (0.73–0.96)

NA = not applicable; RR = relative risk.

* RR >1.00 indicates increased adherence with the recommended screening test, and RR <1.00 indicates decreased adherence.

† We performed univariate analysis and included all the variables with a P value <0.10 in the multivariate model. We evaluated independent variable colinearity by examining variance inflation factors and tolerance. Variables that were highly correlated were not included in the same models.

‡ According to the National Cancer Institute's Common Terminology Criteria for Adverse Events (version 3) grading, 0 = none, 1 = mild, 2 = moderate, 3 = severe, and 4 = life-threatening or disabling.

tions, such as gastric cancer, have also been observed, suggesting that clinicians need to be aware of new symptoms in survivors who have had radiation to any portion of the gastrointestinal tract. Malignant melanoma occurs with increased frequency in survivors of childhood cancer (5, 14, 15), and the cumulative incidence of nonmelanoma skin cancer is almost 7% in 30-year survivors of childhood cancer (2). Thus, the low surveillance rates observed in our cohort suggest that opportunities to detect secondary breast, colorectal, or skin cancer early in its course are being missed, placing some survivors at increased risk for both serious morbidity and mortality.

The dichotomy of low rates of surveillance in the high-risk survivors in the setting of high rates of cancer screening in average-risk survivors suggests that the problem is not simply lack of interest or adherence on the part of the survivors. Survivors were more likely to report an indicated mammogram or skin examination if they received follow-up care at a cancer center or in a long-term follow-up program. However, few survivors (12.4% in this cohort) continue to receive regular care at a cancer center once they reach adulthood (47). Although many pediatric cancer centers offer specialized care to survivors during childhood and adolescence, few provide access to specialized clinics once survivors reach adulthood (48). Several adult cancer centers run survivorship clinics, although these clinics generally target survivors of adult cancer, such as breast or colon cancer, and are not routinely used by survivors of childhood cancer (49, 50).

These data suggest that interventions to improve adherence to cancer surveillance should be directed at the primary care physicians who care for most long-term survivors of childhood cancer, as well as to the survivors themselves. Research has suggested that a physician recommendation is a statistically significant determinant of adherence to mammography guidelines (51). However, because the guidelines for high-risk patients recommend that breast and colorectal cancer surveillance start many years before screening in the general population, many primary care physicians are probably unaware of the surveillance guidelines for these high-risk patients (52). In fact, primary care physicians' lack of familiarity with the health problems faced by survivors has been identified as a substantial barrier to provision of adequate survivor care (52, 53). Targeted education of physicians, open access to guidelines (such as the COG guidelines), and the availability of the pediatric cancer centers as a resource for primary care providers may improve survivor care.

Perhaps most important, survivors must be provided with the knowledge and tools to advocate for their own care. Survivors are often unaware of the details of their cancer therapy, which prevents them from seeking care focused on specific risks (54). Efforts to empower survivors have included provision of treatment summaries and survivor care plans at the end of cancer therapy. Indeed, in our study, survivors who had a summary of their cancer treatment were more likely to report a recommended colonoscopy or skin examination. The feasibility of providing survivors with a portable electronic record of their cancer history and recommended care that can be shared with their health care provider is being assessed.

Our study had several methodological limitations. First, we relied on self-reported data about the completion of screening tests. Although self-reported imaging or diagnostic tests, such as mammography or Papanicolaou smear, have been shown to be generally reliable (55), no evidence suggests that patients accurately report skin examinations. Second, CCSS participants are a selected group of survivors, and their adherence to surveillance recommendations may not be representative of all survivors of childhood cancer. Third, this cohort of survivors received therapy between 1970 and 1986. Caution should be used in generalizing these findings to patients treated more recently. It is plausible that patients treated in the current era are better informed about their need for routine surveillance. The CCSS is currently recruiting a cohort of survivors treated between 1987 and 1999 to examine such questions. Finally, assessment of screening adherence in survivors at average risk for a second malignant neoplasm focused only on women. Too few survivors in the cohort had reached the age when colorectal cancer screening is recommended to assess their adherence with these screening guidelines. Thus, the findings of good adherence in female survivors should not be generalized to male survivors.

In summary, survivors of childhood cancer who are not at increased risk for a second malignant neoplasm show reasonable adherence to Papanicolaou smear and mammography guidelines. However, survivors at increased risk for a second malignant neoplasm during adulthood show very poor adherence to recommended surveillance for breast, colorectal, and skin cancer. Clinicians who care for survivors of childhood cancer must implement and evaluate methods for ensuring better adherence with recommended cancer surveillance and for improving awareness among both the survivors and the primary care clinicians who care for these persons as they age. This should include provision of a treatment summary and care plan to all survivors of childhood cancer before their transition out of a pediatric cancer center.

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Reproducible Research Statement: *Study protocol and statistical code:* Available from Dr. Nathan (e-mail, paul.nathan@sickkids.ca). *Data set:* Available from Dr. Nathan. See www.stjude.org/ccss for description of data utilization procedures.

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References

1. **Mariotto AB, Rowland JH, Yabroff KR, Scoppa S, Hachey M, Ries L, et al.** Long-term survivors of childhood cancers in the United States. Cancer Epidemiol Biomarkers Prev. 2009;18:1033-40. [PMID: 19336557]
2. **Meadows AT, Friedman DL, Neglia JP, Mertens AC, Donaldson SS, Stovall M, et al.** Second neoplasms in survivors of childhood cancer: findings from the Childhood Cancer Survivor Study cohort. J Clin Oncol. 2009;27:2356-62. [PMID: 19255307]
3. **Jenkinson HC, Hawkins MM, Stiller CA, Winter DL, Marsden HB, Stevens MC.** Long-term population-based risks of second malignant neoplasms after childhood cancer in Britain. Br J Cancer. 2004;91:1905-10. [PMID: 15534607]
4. **Bhatia S, Yasui Y, Robison LL, Birch JM, Bogue MK, Diller L, et al; Late Effects Study Group.** High risk of subsequent neoplasms continues with extended follow-up of childhood Hodgkin's disease: report from the Late Effects Study Group. J Clin Oncol. 2003;21:4386-94. [PMID: 14645429]
5. **Olsen JH, Möller T, Anderson H, Langmark F, Sankila R, Tryggvadóttír L, et al.** Lifelong cancer incidence in 47,697 patients treated for childhood cancer in the Nordic countries. J Natl Cancer Inst. 2009;101:806-13. [PMID: 19470947]
6. **Armstrong GT, Liu Q, Yasui Y, Neglia JP, Leisenring W, Robison LL, et al.** Late mortality among 5-year survivors of childhood cancer: a summary from the Childhood Cancer Survivor Study. J Clin Oncol. 2009;27:2328-38. [PMID: 19332714]
7. **Lawless SC, Verma P, Green DM, Mahoney MC.** Mortality experiences among 15+ year survivors of childhood and adolescent cancers. Pediatr Blood Cancer. 2007;48:333-8. [PMID: 16453299]
8. **Sanna G, Lorizzo K, Rotmensz N, Bagnardi V, Cinieri S, Colleoni M, et al.** Breast cancer in Hodgkin's disease and non-Hodgkin's lymphoma survivors. Ann Oncol. 2007;18:288-92. [PMID: 17088328]
9. **Kenney LB, Yasui Y, Inskip PD, Hammond S, Neglia JP, Mertens AC, et al.** Breast cancer after childhood cancer: a report from the Childhood Cancer Survivor Study. Ann Intern Med. 2004;141:590-7. [PMID: 15492338]
10. **Horwich A, Swerdlow AJ.** Second primary breast cancer after Hodgkin's disease. Br J Cancer. 2004;90:294-8. [PMID: 14735166]
11. **Ng AK, Bernardo MV, Weller E, Backstrand K, Silver B, Marcus KC, et al.** Second malignancy after Hodgkin disease treated with radiation therapy with or without chemotherapy: long-term risks and risk factors. Blood. 2002;100:1989-96. [PMID: 12200357]
12. **Metayer C, Lynch CF, Clarke EA, Glimelius B, Storm H, Pukkala E, et al.** Second cancers among long-term survivors of Hodgkin's disease diagnosed in childhood and adolescence. J Clin Oncol. 2000;18:2435-43. [PMID: 10856104]
13. **Hodgson DC, Gilbert ES, Dores GM, Schonfeld SJ, Lynch CF, Storm H, et al.** Long-term solid cancer risk among 5-year survivors of Hodgkin's lymphoma. J Clin Oncol. 2007;25:1489-97. [PMID: 17372278]
14. **Inskip PD, Curtis RE.** New malignancies following childhood cancer in the United States, 1973-2002. Int J Cancer. 2007;121:2233-40. [PMID: 17557301]
15. **Neglia JP, Friedman DL, Yasui Y, Mertens AC, Hammond S, Stovall M, et al.** Second malignant neoplasms in five-year survivors of childhood cancer: childhood cancer survivor study. J Natl Cancer Inst. 2001;93:618-29. [PMID: 11309438]
16. **Perkins JL, Liu Y, Mitby PA, Neglia JP, Hammond S, Stovall M, et al.** Nonmelanoma skin cancer in survivors of childhood and adolescent cancer: a report from the childhood cancer survivor study. J Clin Oncol. 2005;23:3733-41. [PMID: 15923570]
17. **Lu WL, Jansen L, Post WJ, Bonnema J, Van de Velde JC, De Bock GH.** Impact on survival of early detection of isolated breast recurrences after the primary treatment for breast cancer: a meta-analysis. Breast Cancer Res Treat. 2009;114:403-12. [PMID: 18421576]
18. **Moss SM, Ellman R, Coleman D, Chamberlain J.** Survival of patients with breast cancer diagnosed in the United Kingdom trial of early detection of breast cancer. United Kingdom Trial of Early Detection of Breast Cancer Group. J Med Screen. 1994;1:193-8. [PMID: 8790516]
19. **Levin B, Lieberman DA, McFarland B, Smith RA, Brooks D, Andrews KS, et al; American Cancer Society Colorectal Cancer Advisory Group.** Screening and surveillance for the early detection of colorectal cancer and adenomatous polyps, 2008: a joint guideline from the American Cancer Society, the U.S. Multi-Society Task Force on Colorectal Cancer, and the American College of Radiology. CA Cancer J Clin. 2008;58:130-60. [PMID: 18322143]
20. **Wolff T, Tai E, Miller T.** Screening for skin cancer: an update of the evidence for the U.S. Preventive Services Task Force. Ann Intern Med. 2009;150:194-8. [PMID: 19189909]
21. **Saslow D, Boetes C, Burke W, Harms S, Leach MO, Lehman CD, et al; American Cancer Society Breast Cancer Advisory Group.** American Cancer Society guidelines for breast screening with MRI as an adjunct to mammography. CA Cancer J Clin. 2007;57:75-89. [PMID: 17392385]
22. **Maurice A, Evans DG, Shenton A, Ashcroft L, Baildam A, Barr L, et al.** Screening younger women with a family history of breast cancer—does early detection improve outcome? Eur J Cancer. 2006;42:1385-90. [PMID: 16750910]
23. **Children's Oncology Group.** Long-Term Follow-up Guidelines for Survivors of Childhood, Adolescent, and Young Adult Cancers. Accessed at www.survivorshipguidelines.org on 10 August 2010.
24. **Landier W, Bhatia S, Eshelman DA, Forte KJ, Sweeney T, Hester AL, 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;22:4979-90. [PMID: 15576413]
25. **Scottish Collegiate Guidelines Network.** Long-Term Follow-up of Survivors of Childhood Cancer: A National Clinical Guideline. Accessed at www.sign.ac.uk/pdf/sign76.pdf on 10 August 2010.
26. **United Kingdom Children's Cancer Study Group.** Therapy-Based Long-Term Follow-up: Practice Statement. Accessed at www.cclg.org.uk/library/19/PracticeStatement/LTFU-full.pdf on 10 August 2010.
27. **Kremer L, Jaspers M, van Leeuwen F, Versluys B, Bresters D, Bokkerink J.** Landelijke richtlijnen voor follow-up van overlevenden van kinderkanker. Tijdschr Kindergeneeskd. 2006;6:214-8.
28. **Robison LL, Mertens AC, Boice JD, Breslow NE, Donaldson SS, Green DM, et al.** Study design and cohort characteristics of the Childhood Cancer Survivor Study: a multi-institutional collaborative project. Med Pediatr Oncol. 2002;38:229-39. [PMID: 11920786]
29. **Robison LL, Armstrong GT, Boice JD, Chow EJ, Davies SM, Donaldson SS, et al.** The Childhood Cancer Survivor Study: a National Cancer Institute-supported resource for outcome and intervention research. J Clin Oncol. 2009;27:2308-18. [PMID: 19364948]
30. **Leisenring WM, Mertens AC, Armstrong GT, Stovall MA, Neglia JP, Lanctot JQ, et al.** Pediatric cancer survivorship research: experience of the Childhood Cancer Survivor Study. J Clin Oncol. 2009;27:2319-27. [PMID: 19364957]
31. **Mertens AC, Walls RS, Taylor L, Mitby PA, Whitton J, Inskip PD, et al.** Characteristics of childhood cancer survivors predicted their successful tracing. J Clin Epidemiol. 2004;57:933-44. [PMID: 15504636]
32. **Agency for Healthcare Research and Quality.** U.S. Preventive Services Task Force. Accessed at www.ahrq.gov/CLINIC/uspstfix.htm on 10 August 2010.
33. **Centers for Disease Control and Prevention.** National Health Interview Survey 2003 NHIS Data Sets. Accessed at www.cdc.gov/Nchs/nhis/quest_data_related_1997_forward.htm on 10 August 2010.

34. **The Workshop Group.** Reducing deaths from breast cancer in Canada. CMAJ. 1989;141:199-201. [PMID: 2752347]
35. **Oeffinger KC, Mertens AC, Sklar CA, Kawashima T, Hudson MM, Meadows AT, et al; Childhood Cancer Survivor Study.** Chronic health conditions in adult survivors of childhood cancer. N Engl J Med. 2006;355:1572-82. [PMID: 17035650]
36. **Hudson MM, Mertens AC, Yasui Y, Hobbie W, Chen H, Gurney JG, et al; Childhood Cancer Survivor Study Investigators.** Health status of adult long-term survivors of childhood cancer: a report from the Childhood Cancer Survivor Study. JAMA. 2003;290:1583-92. [PMID: 14506117]
37. **Derogatis LR.** BSI-18 Administration, Scoring and Procedures Manual. Minneapolis: National Computer Systems; 2000.
38. **Ware JE Jr, Sherbourne CD.** The MOS 36-item short-form health survey (SF-36). I. Conceptual framework and item selection. Med Care. 1992;30:473-83. [PMID: 1593914]
39. **McNutt LA, Wu C, Xue X, Hafner JP.** Estimating the relative risk in cohort studies and clinical trials of common outcomes. Am J Epidemiol. 2003;157:940-3. [PMID: 12746247]
40. **Allison PD.** Logistic Regression Using the SAS System: Theory and Application. Cary, NC: SAS Press; 2001.
41. **Trask PC, Rabin C, Rogers ML, Whiteley J, Nash J, Frierson G, et al.** Cancer screening practices among cancer survivors. Am J Prev Med. 2005;28:351-6. [PMID: 15831340]
42. **Henderson TO, Amsterdam A, Bhatia S, Hudson MM, Meadows AT, Neglia JP, et al.** Systematic review: surveillance for breast cancer in women treated with chest radiation for childhood, adolescent, or young adult cancer. Ann Intern Med. 2010;152:444-55. [PMID: 20368650]
43. **Ford D, Easton DF, Stratton M, Narod S, Goldgar D, Devilee P, et al.** Genetic heterogeneity and penetrance analysis of the BRCA1 and BRCA2 genes in breast cancer families. The Breast Cancer Linkage Consortium. Am J Hum Genet. 1998;62:676-89. [PMID: 9497246]
44. **Easton DF, Ford D, Bishop DT.** Breast and ovarian cancer incidence in BRCA1-mutation carriers. Breast Cancer Linkage Consortium. Am J Hum Genet. 1995;56:265-71. [PMID: 7825587]
45. **Begg CB, Haile RW, Borg A, Malone KE, Concannon P, Thomas DC, et al.** Variation of breast cancer risk among BRCA1/2 carriers. JAMA. 2008;299:194-201. [PMID: 18182601]
46. **Dores GM, Metayer C, Curtis RE, Lynch CF, Clarke EA, Glimelius B, et al.** Second malignant neoplasms among long-term survivors of Hodgkin's disease: a population-based evaluation over 25 years. J Clin Oncol. 2002;20:3484-94. [PMID: 12177110]
47. **Nathan PC, Greenberg ML, Ness KK, Hudson MM, Mertens AC, Mahoney MC, et al.** Medical care in long-term survivors of childhood cancer: a report from the childhood cancer survivor study. J Clin Oncol. 2008;26:4401-9. [PMID: 18802152]
48. **Hewitt M, Weiner SL, Simone JV, eds.** Childhood Cancer Survivorship: Improving Care and Quality of Life. Washington, DC: National Academies Pr; 2003.
49. **Hewitt M, Greenfield S, Stovall E, eds.** From Cancer Patient to Cancer Survivor: Lost in Transition. Washington, DC: National Academies Pr; 2005.
50. **Oeffinger KC, McCabe MS.** Models for delivering survivorship care. J Clin Oncol. 2006;24:5117-24. [PMID: 17093273]
51. **Oeffinger KC, Ford JS, Moskowitz CS, Diller LR, Hudson MM, Chou JF, et al.** Breast cancer surveillance practices among women previously treated with chest radiation for a childhood cancer. JAMA. 2009;301:404-14. [PMID: 19176442]
52. **Zebrack BJ, Eshelman DA, Hudson MM, Mertens AC, Cotter KL, Foster BM, et al.** Health care for childhood cancer survivors: insights and perspectives from a Delphi panel of young adult survivors of childhood cancer. Cancer. 2004;100:843-50. [PMID: 14770443]
53. **Mertens AC, Cotter KL, Foster BM, Zebrack BJ, Hudson MM, Eshelman D, et al.** Improving health care for adult survivors of childhood cancer: recommendations from a delphi panel of health policy experts. Health Policy. 2004;69:169-78. [PMID: 15212864]
54. **Kadan-Lottick NS, Robison LL, Gurney JG, Neglia JP, Yasui Y, Hayashi R, et al.** Childhood cancer survivors' knowledge about their past diagnosis and treatment: Childhood Cancer Survivor Study. JAMA. 2002;287:1832-9. [PMID: 11939869]
55. **Caplan LS, McQueen DV, Qualters JR, Leff M, Garrett C, Calonge N.** Validity of women's self-reports of cancer screening test utilization in a managed care population. Cancer Epidemiol Biomarkers Prev. 2003;12:1182-7. [PMID: 14652278]

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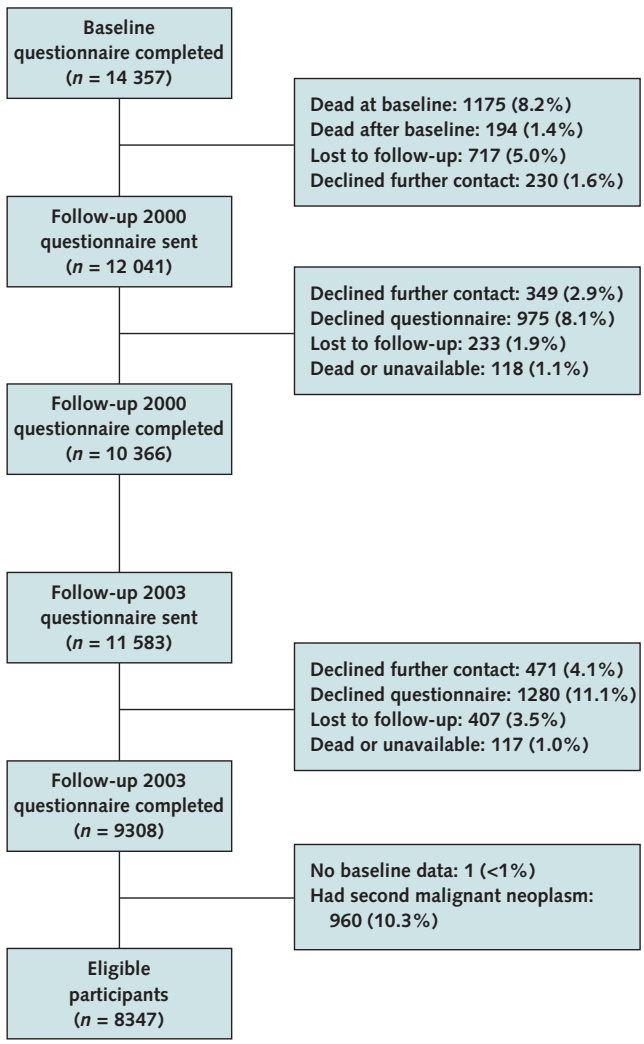
Appendix Figure. **Study flow diagram.**



Appendix Table. **Recommended Screening (USPSTF) and Surveillance (COG) for Survivors at Average or High Risk for a Second Malignant Neoplasm**

Screening in Survivors at Average Risk for a Second Malignant Neoplasm

Type of Cancer	Breast	Cervix	Colorectal	Skin
USPSTF recommended screening for the general (average-risk) population	Mammography every 1 to 2 y for women aged ≥40 y	Papanicolaou smear every 3 y starting at age 21 y*	Because few survivors in the cohort reached the age when colorectal cancer screening in the general population is recommended, this outcome is not presented	Not applicable

Surveillance in Survivors at High Risk for a Second Malignant Neoplasm

Type of Cancer	Breast	Cervix	Colorectal	Skin
COG definition of high-risk group	For women, ≥20 Gy radiation therapy to the chest	Not applicable	≥30 Gy radiation therapy to the abdomen, pelvis, or spine	Any radiation therapy
COG recommended surveillance for high-risk survivors	Annual mammography starting 8 y after radiation or at age 25 y, whichever is last†	Not applicable	Colonoscopy every 5 y starting at age 35 y	Annual dermatologic examination of irradiated areas

COG = Children's Oncology Group; USPSTF = U.S. Preventive Services Task Force.

* Guideline recommends Papanicolaou smear screening starting at time of first sexual intercourse or age 21 years, whichever is earlier (www.uspreventiveservicestaskforce.org/clinic/3rduspstf/cervcan/cervcanrr.htm). Because time of first intercourse was not captured by the study questionnaire, we used age 21 y as the expected time of the commencement of screening.

† Breast magnetic resonance imaging was identified as an adjunct to mammography in a revised version of the COG surveillance guidelines published in 2008, after the completion of the study surveys. Magnetic resonance imaging was not assessed in our analysis.