International Guideline Harmonization Group Recommendations for Breast Cancer Surveillance in Childhood, Adolescent, and Young Adult Cancer Survivors After Anthracyclines

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ABSTRACT

PURPOSE With new evidence emerging about breast cancer risk following anthracycline chemotherapy, the International Late Effects of Childhood Cancer Guideline Harmonization Group updated the evidence and breast cancer surveillance recommendations for female childhood, adolescent, and young adult (CAYA) cancer survivors.

METHODS The Grading of Recommendations Assessment, Development, and Evaluation methodology was used to incorporate new knowledge and refine breast cancer surveillance recommendations. The guideline panel updated the systematic literature review and revised recommendations based on new evidence, clinical judgment, and assessments of benefits and harms of surveillance, ensuring adaptability across various health care systems.

RESULTS The literature update revealed new findings on the effects of anthracyclines on breast cancer risk in female CAYA cancer survivors. Moderate-quality evidence shows no significant association between doxorubicin doses <100 mg/m² and breast cancer risk. High-quality evidence indicates a statistically significant but weak association between breast cancer risk and 100-199 mg/m² doxorubicin (relative risk, <2) and a moderate breast cancer risk (relative risk, 2-4) for those treated with ≥200 mg/m² in the absence of radiotherapy exposing breast tissue (chest radiation). Routine breast cancer surveillance after ≥200 mg/m² doxorubicin in the absence of chest radiation is reasonable from age 30 years onward or ≥8 years from exposure (whichever occurs last). Due to inconclusive evidence, no recommendation could be formulated for routine breast cancer surveillance after daunorubicin, epirubicin, or idarubicin, in the absence of chest radiation.

CONCLUSION The newly identified evidence on breast cancer risk after anthracyclines supports changes in the 2019 recommendations regarding breast cancer surveillance for survivors treated with ≥200 mg/m² doxorubicin without chest radiation.

ACCOMPANYING CONTENT

Appendix

Data Supplement

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INTRODUCTION

Women treated with external beam radiotherapy exposing breast tissue (chest radiation) for childhood, adolescent, or young adult (CAYA) cancer have an increased risk of early-onset breast cancer.[1] Additionally, treatment with anthracycline chemotherapy has been associated with an increased risk of developing subsequent breast cancer in CAYA cancer survivors.[2-6] Overall, the cumulative incidence of breast cancer among childhood cancer survivors is as high as 18.1% by age 55 years.[7] For childhood Hodgkin lymphoma survivors treated with higher doses and larger volumes of radiation to the breasts, this risk can reach up to 35% by age 50, comparable with the risk observed in carriers of BRCA gene mutations.[8-10] Research indicates that the breast cancer risk remains elevated in CAYA cancer survivors age 60 years and older.[11,12] Moreover, mortality rates after a breast cancer diagnosis are higher among affected CAYA cancer survivors

compared with women with primary breast cancer.[13-15] Due to the significant risk, personalized long-term breast surveillance is advised for female CAYA cancer survivors exposed to chest radiation.[1]

In the 2020 International Late Effects of Childhood Cancer Guideline Harmonization Group (IGHG) breast cancer surveillance guideline update, annual breast cancer surveillance with both mammography and magnetic resonance imaging (MRI) was recommended for CAYA cancer survivors treated with ≥10 Gy chest radiation starting at age 25 years or 8 years after radiation, whichever occurs last, for at least up to 60 years of age. Moreover, no recommendations could be formulated for routine breast cancer surveillance after treatment with anthracyclines because of inconclusive evidence.[1] Since then, important new studies have become available,[3,16] prompting a re-evaluation of the evidence and potential update of the recommendations.

We present the updated recommendations following consideration of new data regarding the breast cancer risk associated with anthracycline chemotherapy, in the absence of chest radiation, while balancing the potential benefits and harms of surveillance.

METHODS

Guideline Development Panel

Twenty-five representatives from the North American Children's Oncology Group, Dutch Childhood Oncology Group, Scottish Intercollegiate Guidelines Network, United Kingdom Children's Cancer and Leukemia Group, and other international pediatric oncology societies and institutions participated in a guideline panel tasked with updating the IGHG breast cancer surveillance recommendations (Appendix Table A1, online only). Panelists were selected for their expertise in the fields of pediatric, radiation, and medical oncology; breast cancer; survivorship care; cancer prevention; primary care; diagnostic imaging; epidemiology; and guideline methodology.

Scope and Definitions

This updated guideline aims to offer tailored recommendations for breast cancer surveillance to health care providers and female CAYA cancer survivors who have been treated with anthracyclines. The target population includes females diagnosed with cancer before age 30 years and more than 2 years after treatment. We assessed the following anthracycline derivates: doxorubicin, daunorubicin, epirubicin, and idarubicin, either individually or as a group.

Systematic Literature Review

IGHG's methodology has been detailed in previous publications.[1,17,18] The guideline panel formulated clinical questions concerning the breast cancer risk in female CAYA cancer survivors treated with anthracyclines (Data Supplement, online only). The systematic literature search was updated, covering the period from June 2019 to March 2025. The search was conducted in MEDLINE (via PubMed) using the terms breast cancer, secondary tumor, and survivor (detailed strategy provided in the Data Supplement). Inclusion criteria are outlined in the Data Supplement. Two independent reviewers determined whether the identified articles met the inclusion criteria. Subsequently, all guideline members were contacted to identify articles or evidence that may have been overlooked.

Evidence summaries were prepared using standardized data extraction forms to address the clinical questions. Subsequently, summary of findings tables and conclusions of evidence were generated for every clinical question. The quality of evidence was evaluated using the Grading of Recommendations Assessment, Development, and Evaluation (GRADE) methodology (Data Supplement).[19]

Translating Evidence Into Recommendations

The GRADE Evidence-to-Decision Framework was applied to ensure a systematic and transparent process for formulating recommendations.[20] Recommendations were developed by weighing the available evidence, clinical judgments, decisions on thresholds, costs, and the potential harms and benefits of surveillance while also considering the need for flexible implementation across various health care systems. Group consensus guided these decisions, and the strength of each recommendation was rated using established evidence-based methods (Data Supplement).[19,21]

CAYA cancer survivors were classified as high-risk if their relative risk of breast cancer was >4 times higher than that of survivors not exposed to a specific treatment, moderate-risk if the risk was 2-4 times higher, and low-risk if the risk was <2 times higher, consistent with breast cancer screening guidelines for the general population.[22-24] A strong recommendation was made when consistent; high-quality evidence indicated a highly increased breast cancer risk following a particular exposure and when the benefits of surveillance clearly outweigh the harms. A moderate recommendation was made when high-quality evidence indicated a moderately increased breast cancer risk and when the benefits of surveillance probably outweigh the harms. For a moderate recommendation, the surveillance decision should be an individual one, considering other contributing factors and personal values.

To promote informed decision making, we updated the Survivor Information Form to facilitate discussion of potential benefits and harms of surveillance between the patient and health care provider. The updated recommendations were critically appraised by two survivor advocates.

RESULTS

We identified five newly published studies on the breast cancer risk following anthracycline exposure in female CAYA

cancer survivors,[3,7,16,25,26] in addition to the five studies included in the previous version of the guideline (Data Supplement).[2,4-6,27] This includes the individual patient data (IPD) cohort analyses conducted by Wang et al,[3] which involved a pooled cohort of 17,903 5-year childhood cancer survivors. The data were drawn from five cohort studies—Childhood Cancer Survivor Study (CCSS; 9,671 women), St Jude Lifetime Cohort Study (2,236 women), Dutch Childhood Cancer Survivor Study LATER (2,237 women), French Childhood Cancer Survivor Study (3,415 women), and the Dutch Hodgkin Late Effects cohort (265 women)—as well as one case-cohort study, the Swiss Childhood Cancer Survivor Study (79 women), spanning Europe and North America. The new data led to changes in the recommendations originally formulated in 2019.[1]

Modified recommendations include routine breast cancer surveillance for survivors treated with ≥200 mg/m² doxorubicin in the absence of chest radiation (moderate recommendation) from age 30 years onward. Due to inconclusive evidence, no recommendation could be formulated for routine breast cancer surveillance for survivors treated with other types of anthracyclines, that is, daunorubicin, epirubicin, or idarubicin, in the absence of chest radiation (Table 1 and Fig 1). The conclusions of evidence are presented in Table 2. The data supplement includes an overview of studies from the updated literature search (Data Supplement), evidence tables, and the summary of findings tables (Data Supplement).

Breast Cancer Risk After Anthracyclines

Evidence shows that female CAYA cancer survivors treated with anthracyclines (as a group) have a dose-dependent increase in breast cancer risk (high-quality evidence). Four studies have specifically assessed the effects of doxorubicin, including Neppelenbroek et al[16] with a median follow-up of 21.6 years (IQR, 15.8-27.1) and the IPD cohort study by Wang et al[3] with a median follow-up of 24.9 years (IQR, 19.1-33.2), incorporating the cohorts from Teepen et al,[4] Veiga et al,[6] and Ehrhardt et al,[2] and in part the patients with childhood cancer from Neppelenbroek et al.[16] There is high-quality evidence for a dose-response relationship among doxorubicin-exposed childhood cancer survivors treated with and without chest radiation.[3] Although potentially elevated, studies have not observed a statistically significant association between a cumulative doxorubicin dose of <100 mg/m² and breast cancer risk (moderate-quality evidence, hazard ratio [HR], 1.76 [95% CI, 0.88 to 3.51]). For survivors treated with 100-199 mg/m² of doxorubicin, however, high-quality evidence indicates a 1.77-fold (95% CI, 1.30 to 2.42) increased breast cancer risk, that is, below the IGHG-defined relative risk threshold of 2 for classification as a moderate-risk group for surveillance purposes.[3] Additionally, high-quality evidence shows a moderate increase in breast cancer risk for women receiving doxorubicin doses of 200 mg/m² or higher, even when controlling for chest radiation. The HRs were 2.50 (95% CI, 1.85 to 3.40) for 200-299 mg/m², 2.33 (95% CI, 1.68 to 3.23) for 300-399 mg/m², and 2.78 (95% CI, 1.99 to 3.88) for doses of 400 mg/m² or more, respectively. After excluding patients who had received chest radiotherapy, the HRs were 2.79 (95% CI, 1.67 to 4.66) for doses of 200-299 mg/m², 2.65 (95% CI, 1.69 to 4.14) for doses of 300-399 mg/m², and 3.65 (95% CI, 2.41 to 5.53) for doses of ≥400 mg/m².[3] All studies examined breast cancer risk after doxorubicin in childhood cancer survivors up to age 21 years at primary cancer diagnosis. Neppelenbroek et al[16] reported age-specific HRs for Hodgkin lymphoma survivors diagnosed at 0-20 years and 21-50 years, finding HRs of 1.8 (95% CI, 1.05 to 3.3) and 1.4 (95% CI, 0.9 to 2.0), respectively, after doxorubicin doses of ≥200 mg/m².

Two studies have examined breast cancer risk following daunorubicin treatment, but neither demonstrated a statistically significant effect (low-quality evidence).[3,6] Currently, the evidence remains inconclusive regarding the impact of daunorubicin and the risk associated with different dose categories in female CAYA cancer survivors. In the pooled IPD cohort reported by Wang et al,[3] 40 of 2,221 female

TABLE 1. Modifications to the Breast Cancer Surveillance Recommendations for Female CAYA Cancer Survivors Exposed to Anthracyclines Formulated in 2019 Versus 2025

2019	2025
No recommendation can be formulated for routine breast cancer surveillance for CAYA cancer survivors treated with any type of anthracyclines in the absence of chest radiation because there is currently inconsistent evidence	Moderate recommendation to perform breast cancer surveillance for female CAYA cancer survivors treated with ≥200 mg/m² doxorubicin in the absence of chest radiation (high-quality evidence).[1] The surveillance decision should be an individual one, considering other contributing factors[2] and personal values regarding harms and benefits of surveillance[3]
	No recommendation can be formulated for routine breast cancer surveillance for female CAYA cancer survivors treated with other types of anthracyclines, ie, daunorubicin, epirubicin, or idarubicin, in the absence of chest radiation because there is currently inconclusive evidence

NOTE. (1) High-quality evidence for a moderate breast cancer risk (relative risk between two and 4), in which the benefits of breast cancer surveillance probably outweigh the harms. (2) Patient age, family history, menopausal status, and other previous cancer treatment, such as chest radiation, pelvic radiation, and alkylating agents. (3) Figure 1 presents the recommendations on when to initiate surveillance, how often it should be conducted, and which surveillance modalities are recommended.
Abbreviation: CAYA, childhood, adolescent, and young adult.

General recommendation
Providers and female CAYA cancer survivors treated with ≥200 mg/m^2 doxorubicin in the absence of chest radiation (high-quality evidence) should be aware of the increased risk of breast cancer (strong recommendation)
Who needs breast cancer surveillance?
Breast cancer surveillance is reasonable for female CAYA cancer survivors treated with ≥200 mg/m^2 doxorubicin in the absence of chest radiation (high-quality evidence).[1] The surveillance decision should be an individual one, considering other contributing factors[2] and personal values regarding harms and benefits of surveillance (moderate recommendation)
No recommendation can be formulated for routine breast cancer surveillance for CAYA cancer survivors treated with other types of anthracyclines, ie, daunorubicin, epirubicin, or idarubicin, in the absence of chest radiation, because there is currently inconclusive evidence. Because the evidence suggests that survivors treated with ≥200 mg/m^2 doxorubicin have a moderately increased breast cancer risk, the decision to undertake breast cancer surveillance for CAYA cancer survivors treated with daunorubicin, epirubicin, or idarubicin should be made by the survivor and healthcare provider after careful consideration of the potential harms and benefits of breast cancer surveillance and considering other contributing factors[2]
At what age should breast cancer surveillance be initiated?
If the decision to commence surveillance is made for female CAYA cancer survivors treated with ≥ 200 mg/m^2 doxorubicin in the absence of chest radiation, initiation of breast cancer surveillance is reasonable at age 30 years or ≥8 years from exposure (whichever occurs last). The decision on when to initiate surveillance should be based on clinical judgment, considering other contributing factors[2] and personal values regarding harms and benefits of surveillance (moderate-quality evidence and expert opinion, moderate recommendation)
At what frequency should breast cancer surveillance be performed?
If the decision to commence surveillance is made for female CAYA cancer survivors treated with ≥200 mg/m^2 doxorubicin in the absence of chest radiation, it is recommended that the frequency of breast cancer surveillance should adhere to national or local breast cancer screening guidelines for moderate-risk individuals (expert opinion, strong recommendation)
At what age should continuation of intensive[3] breast cancer surveillance be stopped?
If the decision to commence surveillance is made for female CAYA cancer survivors treated with ≥200 mg/m^2 doxorubicin in the absence of chest radiation, it is recommended that the continuation of breast cancer surveillance should adhere to national or local breast cancer screening guidelines for moderate-risk individuals (expert opinion, strong recommendation)
What surveillance modality should be used?
If the decision to commence surveillance is made for female CAYA cancer survivors treated with ≥200 mg/m^2 doxorubicin in the absence of chest radiation, mammography is recommended for breast cancer surveillance (existing guidelines, strong recommendation) The use of breast MRI can be considered according to the national or local breast cancer screening guidelines for moderate-risk individuals (expert opinion, strong recommendation)

FIG 1. Updated harmonized recommendations for breast cancer surveillance for female survivors of CAYA cancer exposed to anthracyclines. The recommendations for CAYA cancer survivors treated with chest radiation are presented in Figure 2 and the Data Supplement. Green represents a strong recommendation with a low degree of uncertainty. Yellow represents a moderate recommendation with a higher degree of uncertainty. (1) High-quality evidence for a moderate breast cancer risk (relative risk between 2 and 4), in which the benefits of breast cancer surveillance probably outweigh the harms. (2) Patient age, family history, genetic profile, menopausal status, and other previous cancer treatments, such as chest radiation, pelvic radiation, and alkylating agents. (3) Recommended breast cancer surveillance beyond the national breast cancer screening program. CAYA, childhood, adolescent, and young adult; MRI, magnetic resonance imaging.

survivors exposed to daunorubicin (any dose) developed a subsequent breast cancer, of which 17 occurred among the 645 survivors who had received ≥200 mg/m^2 daunorubicin.

For epirubicin, there is moderate-quality evidence indicating an increased breast cancer risk among survivors (HR, 3.40, 95% CI, 1.66 to 6.98). However, data on the dose-response relationship are lacking, and no significant effect has been observed in survivors treated with epirubicin who did not receive chest radiation. Similar to daunorubicin, only a small proportion of individuals were exposed to high doses of epirubicin.[3] No studies reported on the effects of idarubicin.

Breast Cancer Risk Over Time

The breast cancer risk seems to increase as early as an attained age of 30 years in female CAYA cancer survivors treated with ≥200 mg/m^2 doxorubicin.[3] The cumulative breast cancer incidence in this patient group increases with increasing length of follow-up, at least up to age 50 years (moderate-quality evidence).[3] In survivors who did not

TABLE 2. Conclusions of Evidence From the Systematic Literature Search for Breast Cancer Surveillance for Female CAYA Cancer Survivors Exposed to Anthracyclines in 2019 Versus 2025

Breast Cancer Risk in CAYA Cancer Survivors	GRADE Level of Evidence 2019
Increased risk after anthracyclines *v* no anthracyclines in a dose-response relationship. However, the dose cutoff for survivors at low, moderate, and high risk is difficult to determine	⊕⊕⊕⊕ HIGH[2-6,27]
Breast cancer risk in CAYA cancer survivors	**GRADE level of evidence 2025**
Increased dose-dependent risk after anthracyclines *v* no anthracyclines	⊕⊕⊕⊕ HIGH[2,4-7,25-27]
Increased dose-dependent risk after doxorubicin *v* no doxorubicin	⊕⊕⊕⊕ HIGH[3,4,6,16]
No significant effect after a cumulative doxorubicin dose of <100 mg/m² *v* no doxorubicin	⊕⊕⊕⊖ MODERATE[3,16]
Low risk (effect estimate <2) after a cumulative doxorubicin dose of 100-199 mg/m² *v* no doxorubicin	⊕⊕⊕⊕ HIGH[3]
Moderate risk (effect estimate 2-4) after a cumulative doxorubicin dose of ≥200 mg/m² *v* no doxorubicin	⊕⊕⊕⊕ HIGH[3]
Inconclusive evidence for effects of daunorubicin *v* no daunorubicin and the effects per dose category	⊕⊕⊖⊖ LOW[3,6]
Increased risk after epirubicin *v* no epirubicin However, there is insufficient information on the dose-response relation and there is no significant effect of epirubicin in survivors treated without chest radiation	⊕⊕⊕⊖ MODERATE[3]
Breast cancer risk over time in CAYA cancer survivors	**GRADE level of evidence 2025**
Increased risk as early as an attained age of 30 years after ≥200 mg/m² doxorubicin in the absence of chest radiation Risk increases with increasing length of follow-up at least up to an attained age of 50 years	⊕⊕⊕⊖ MODERATE[3]

Abbreviations: CAYA, childhood, adolescent, and young adult; GRADE, Grading of Recommendations Assessment, Development, and Evaluation.

receive chest radiation, the cumulative incidences at age 40 years were 0.8% in survivors treated without doxorubicin, 1.9% in survivors treated with a cumulative doxorubicin dose below 200 mg/m², and 3.4% in survivors treated with a cumulative doxorubicin dose of 200 mg/m² and greater.[3] In contrast, among survivors who received chest radiotherapy, the univariable cumulative incidences at age 40 were 7.9% in the no doxorubicin group, 10.1% in the group with a cumulative doxorubicin dose below 200 mg/m², and 8.1% in the group with a cumulative doxorubicin dose of 200 mg/m² and greater.[3] Currently, there are no published data about the latency from doxorubicin exposure to developing breast cancer.

Translating Evidence Into Recommendations

The Data Supplement provides the Evidence-to-Decision Framework and Figure 1 the breast cancer surveillance recommendations after anthracycline exposure. Figure 2 and the Data Supplement present an overview of the breast cancer surveillance recommendations, including survivors treated with and without chest radiation.

Studies of women age 40-75 years in the general population have demonstrated that mammography screening significantly reduces breast cancer mortality.[28,29] Recent findings showed that Hodgkin lymphoma survivors with screen-detected breast cancer have a 61% lower risk of breast cancer–specific mortality compared with those with non–screen-detected cases.[14] Additionally, for women with node-positive breast cancer, previous treatment for CAYA cancer may restrict the use of anthracycline-based adjuvant therapy or additional radiation for subsequent breast cancer, potentially leading to worse outcomes.[30,31] Moreover, recent studies have shown that CAYA cancer survivors who develop a subsequent breast cancer have a higher mortality rate than women with primary breast cancer, highlighting the importance of early detection in this population.[14,15] Potential harms of surveillance include false-positive results leading to unnecessary emotional distress and additional imaging or biopsies and false-negative findings causing false reassurance, overdiagnosis, the burden of regular surveillance, and potential radiation exposure from mammography; however, newer methods have minimized this exposure significantly.[28,29,32] It is crucial to consider the threshold where the benefits outweigh the harms. The guideline panel concluded that for patients treated with doxorubicin doses of 200 mg/m² or above—a group with a relative risk of breast cancer that is more than two times the risk in survivors not exposed to anthracyclines—the benefits of breast cancer surveillance are expected to probably outweigh the harms. Therefore, breast cancer surveillance is reasonable for female CAYA cancer survivors treated with doxorubicin doses of 200 mg/m² and greater (high-quality evidence). The surveillance decision should be an individual one, considering other contributing factors (ie, patient age, family history, genetic profile, menopausal status, other cancer treatment exposures like chest radiation and ovarian-toxic therapy) and personal values regarding harms and benefits of surveillance (moderate recommendation). Shared decision making can be facilitated by the Survivor Information Form (Data Supplement).

Because evidence remains inconclusive, no recommendation can be formulated for routine breast cancer surveillance for CAYA cancer survivors treated with other types of anthracyclines (ie, daunorubicin, epirubicin or idarubicin) in the absence of chest radiation. Since evidence indicates that survivors who received doxorubicin doses of 200 mg/m² and above face a moderately increased risk of breast cancer, the

		Chest Radiation		
		<10 Gy chest radiation	≥10 Gy chest radiation	Upper abdominal radiation exposing breast tissue
Anthracyclines	<200 mg/m² doxorubicin	-	Annual mammogram and MRI starting at age 25 years	Annual mammogram and MRI starting at age 25 years
	≥200 mg/m² doxorubicin	Mammogram or MRI starting at age 30 years[a]	Annual mammogram and MRI starting at age 25 years	Annual mammogram and MRI starting at age 25 years

FIG 2. Overview of harmonized recommendations for breast cancer surveillance for female survivors of childhood, adolescent, and young adult cancer. Green represents a strong recommendation with a low degree of uncertainty. Yellow represents a moderate recommendation with a higher degree of uncertainty. [a]Frequency of breast cancer surveillance should adhere to national or local breast cancer screening guidelines for moderate-risk individuals. MRI, magnetic resonance imaging

decision for survivors treated with daunorubicin, epirubicin, or idarubicin to undergo breast cancer surveillance should be made jointly by the survivor and their health care provider. This decision should involve a thorough evaluation of the potential benefits and harms of surveillance, along with any other contributing factors.

Defining an appropriate surveillance starting point and interval is challenging, but early detection is critical, as diagnosing breast cancer at an early stage improves the chances of favorable outcomes and survival.[33,34] In female CAYA cancer survivors treated with ≥200 mg/m² of doxorubicin, the breast cancer risk appears to start increasing as early as age 30 years (moderate-quality evidence).[3] A modeling study by Yeh et al[35] evaluated the clinical benefits, harms, and costs of breast cancer screening for childhood cancer survivors who were not treated with chest radiation. The study found that the balance between false-positive screening results and breast cancer deaths averted among survivors for screening starting between ages 25 and 40 years was reasonable when compared with benchmarks for average-risk women, although screening starting at age 40 years was the only cost-effective strategy given commonly used thresholds. However, the analysis did not consider anthracycline dose. Regarding latency periods, precise data are not available following doxorubicin treatment. On the basis of unpublished data from Wang et al[3] (Data Supplement), the breast cancer incidence appears to increase around 8-10 years after primary cancer diagnosis, a pattern also observed in survivors who received chest radiation.

For women exposed to chest radiation, the IGHG recommends initiating surveillance at age 25 or 8 years after radiation, whichever occurs last.[1] Although the appropriate timing for doxorubicin-related surveillance remains somewhat arbitrary due to the lack of precise latency data, we believe there is currently no strong rationale to deviate from the 8-year interval. Taking these considerations into account, the guideline panel reached consensus that starting surveillance at age 30 years or ≥8 years from exposure (whichever occurs last) after doxorubicin doses of 200 mg/m² or higher is reasonable. The age to begin surveillance should be determined through clinical judgment, taking into account other contributing factors as well as the individual's personal values concerning the potential harms and benefits of surveillance.

Regarding the most appropriate screening interval, there are currently no data about the progression of carcinogenesis after anthracyclines. For moderate-risk females, breast cancer screening practices vary significantly between countries due to differences in health care policies and risk assessment criteria. In some countries, such as the United States, guidelines recommend annual mammography and MRI starting at age 30 years for those with a lifetime risk of 20% and higher.[24] European countries, on the other hand, often adopt a more conservative approach; for example, in the Netherlands a yearly mammogram from age 40-49 years and biennial from age 50-75 years is recommended, whereas a breast MRI is not recommended for women with a familial moderate lifetime risk of 20%-30%.[23] Due to these significant variations in screening interval and modality recommendations for moderate-risk groups across different countries, the guideline panel recommends adherence to the national or local guidelines for determination of surveillance intervals and continuation of surveillance when screening for the general population starts (strong recommendation).

For high-risk individuals (relative risk >4) in the general population, combined surveillance using mammography and breast MRI is recommended, consistent with previous IGHG recommendations.[1] For moderate-risk patients (relative risk, 2-4) in the general population, mammography is the standard surveillance modality.[23,24,36] Therefore, mammography only is recommended for breast cancer surveillance in female CAYA cancer survivors treated with ≥200 mg/m² doxorubicin. The use of breast MRI (ie, to enhance diagnostic accuracy in young individuals or those with dense breast tissue) can be considered according to the national or

local breast cancer screening guidelines for moderate-risk individuals (expert opinion).

DISCUSSION

Recent evidence has prompted significant updates to breast cancer surveillance recommendations for female CAYA cancer survivors treated with anthracyclines without a history of chest radiation.

High-quality evidence for a moderate increased breast cancer risk after doxorubicin doses of 200 mg/m² and higher supports a moderate recommendation for routine breast cancer surveillance for this patient group. An individualized approach is essential, weighing the potential benefits and harms of surveillance. The guideline panel was unable to formulate a recommendation for breast cancer surveillance in females treated with daunorubicin, epirubicin, or idarubicin without chest radiation due to inconclusive evidence regarding breast cancer risk.

The combined effects of doxorubicin and chest radiotherapy seem to be additive.[3,6] However, since survivors treated with chest radiation are already following a more intensive surveillance schedule,[1] the recommendations remain unchanged for those who have received both doxorubicin and chest radiation. In some instances, a combination of anthracyclines may have been administered. For survivors treated with a combination of doxorubicin doses below 200 mg/m² and another anthracycline agent, decisions regarding breast cancer surveillance should be made on an individual basis by the survivor and their health care provider. This decision should consider other contributing factors and involve a thorough evaluation of the potential benefits and harms of surveillance.

The mechanisms underlying the increased risk of breast cancer associated with anthracyclines are not well understood. Anthracyclines are known to exhibit mutagenic properties that may contribute to the breast cancer risk, including topoisomerase II inhibition, oxidative stress, DNA intercalation, and chromatin damage.[37] The precise mechanisms driving the differences in breast cancer development after various anthracycline agents remain unclear. Animal studies suggest that both doxorubicin and daunorubicin can induce mammary tumors.[38,39] The antineoplastic effects of these agents are believed to stem from their ability to cause DNA and chromatin damage.[37] Although data are limited, their anticancer efficacy is generally considered comparable. A potential explanation for the differences in dose-response effects observed between doxorubicin and daunorubicin is the smaller number of patients and breast cancer cases among those exposed to daunorubicin. This may have reduced the statistical power to detect a significant dose-response relationship. Another hypothesis is that daunorubicin may be less toxic than doxorubicin, with increased risks potentially becoming apparent only at higher doses. However, there are currently no data available to support this assumption. Future research could explore the concept of anthracycline equivalence dosing in relation to breast cancer risk.

Previous studies among childhood cancer survivors found that the increased risk of breast cancer and the dose-response relationship with doxorubicin were more pronounced in survivors with primary cancer types typically associated with the Li-Fraumeni (like) syndrome, such as leukemia, sarcoma, and brain tumors, compared with survivors of other solid tumors and lymphomas. This may suggest a potential interaction between genetic factors and anthracycline exposure in breast cancer development.[4,5] However, findings from the St Jude Lifetime Cohort Study, including 1,467 female 10-year childhood cancer survivors, demonstrated that the increased breast cancer risk associated with higher anthracycline doses occurs independently of mutations in autosomal dominantly inherited cancer predisposition gene mutations, including *TP53* mutations.[2] Similarly, Neppelenbroek et al[16] in their cohort study of survivors of Hodgkin lymphoma, demonstrated that the doxorubicin-related breast cancer risk is not limited to survivors of childhood cancer types linked to Li-Fraumeni syndrome. These results highlight the need for further research to explore the potential roles of genetic and metabolic factors in the relationship between doxorubicin exposure and breast cancer risk.

Despite advances in understanding breast cancer risk factors, a gap remains in the development of comprehensive risk prediction models that account for the multifactorial nature of breast cancer. Moskowitz et al[26] developed and validated a breast cancer risk prediction model tailored for childhood cancer survivors who underwent chest radiation. Using data from the CCSS and the Dutch Hodgkin Late Effects and LATER cohorts, the model incorporates key contributing factors such as radiation dose, age at exposure, anthracycline exposure, hormonal and reproductive history, genetic profile, and family history of breast cancer, but they have not yet integrated the role of doxorubicin dose in the absence of chest radiation. This limits the ability to provide personalized risk assessments and targeted interventions for this group of survivors. Developing and implementing prediction models that incorporate complex interactions is critical for advancing person-centered care and improving long-term outcomes for CAYA cancer survivors.

Our process is strengthened by its evidence-based foundation, transparent methodology for deriving and rating the

TABLE 3. Gaps in Knowledge and Directions for Future Research

Knowledge Gaps in CAYA Cancer Survivors
Potential gene-anthracycline interaction on the breast cancer risk
Potential anthracycline equivalence dose in relation to breast cancer
Lack of a breast cancer risk prediction model addressing the multifactorial risks contributing to breast cancer
Effects of breast cancer screening on mortality

Abbreviation: CAYA, childhood, adolescent, and young adult.

strength of recommendations, and the involvement of a multidisciplinary working group in the harmonization process. The ongoing collaboration between evidence appraisers and recommendation formulators further enhances the validity and credibility of our guideline development approach.

The IGHG breast cancer surveillance guideline is designed to improve health outcomes by promoting consistent, long-term follow-up care for female CAYA cancer survivors. Additionally, it seeks to drive strategically planned research to inform and refine future updates to the guidelines (Table 3).

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REFERENCES

1. Mulder RL, Hudson MM, Bhatia S, et al: Updated breast cancer surveillance recommendations for female survivors of childhood, adolescent, and young adult cancer from the International Guideline harmonization Group. J Clin Oncol 38:4194-4207, 2020
2. Ehrhardt MJ, Howell CR, Hale K, et al: Subsequent breast cancer in female childhood cancer survivors in the St Jude Lifetime Cohort Study (SJLIFE). J Clin Oncol 37:1647-1656, 2019
3. Wang Y, Ronckers CM, van Leeuwen FE, et al: Subsequent female breast cancer risk associated with anthracycline chemotherapy for childhood cancer. Nat Med 29:2268-2277, 2023
4. Teepen JC, van Leeuwen FE, Tissing WJ, et al: Long-term risk of subsequent malignant neoplasms after treatment of childhood cancer in the DCOG LATER study cohort: Role of chemotherapy. J Clin Oncol 35:2288-2298, 2017
5. Henderson TO, Moskowitz CS, Chou JF, et al: Breast cancer risk in childhood cancer survivors without a history of chest radiotherapy: A report from the childhood cancer survivor study. J Clin Oncol 34:910-918, 2016
6. Veiga LH, Curtis RE, Morton LM, et al: Association of breast cancer risk after childhood cancer with radiation dose to the breast and anthracycline use: A report from the childhood cancer survivor study. JAMA Pediatr 173:1171-1179, 2019
7. Henderson TO, Liu Q, Turcotte LM, et al: Association of changes in cancer therapy over 3 decades with risk of subsequent breast cancer among female childhood cancer survivors: A report from the Childhood Cancer Survivor Study (CCSS). JAMA Oncol 8:1765-1774, 2022
8. Moskowitz CS, Chou JF, Wolden SL, et al: Breast cancer after chest radiation therapy for childhood cancer. J Clin Oncol 32:2217-2223, 2014
9. Taylor AJ, Winter DL, Stiller CA, et al: Risk of breast cancer in female survivors of childhood Hodgkin's disease in Britain: A population-based study. Int J Cancer 120:384-391, 2007
10. Roberti S, van Leeuwen FE, Diallo I, et al: Prediction of breast cancer risk for adolescents and young adults with Hodgkin lymphoma. J Natl Cancer Inst 117:619-628, 2025
11. Schaapveld M, Aleman BM, van Eggermond AM, et al: Second cancer risk up to 40 years after treatment for Hodgkin's lymphoma. N Engl J Med 373:2499-2511, 2015
12. Swerdlow AJ, Cooke R, Bates A, et al: Breast cancer risk after supradiaphragmatic radiotherapy for Hodgkin's lymphoma in England and Wales: A National Cohort Study. J Clin Oncol 30:2745-2752, 2012
13. Moskowitz CS, Chou JF, Neglia JP, et al: Mortality after breast cancer among survivors of childhood cancer: A report from the Childhood Cancer Survivor Study. J Clin Oncol 37:2120-2130, 2019
14. Krul IM, Boekel NB, Kramer I, et al: Breast cancer and cardiovascular outcomes after breast cancer in survivors of Hodgkin lymphoma. Cancer 128:4285-4295, 2022
15. Im C, Hasan H, Stene E, et al: Treatment, toxicity, and mortality after subsequent breast cancer in female survivors of childhood cancer. Nat Commun 16:3088, 2025
16. Neppelenbroek SIM, Geurts YM, Aleman BMP, et al: Doxorubicin exposure and breast cancer risk in survivors of adolescent and adult Hodgkin lymphoma. J Clin Oncol 42:1903-1913, 2024
17. Kremer LC, Mulder RL, Oeffinger KC, et al: A worldwide collaboration to harmonize guidelines for the long-term follow-up of childhood and young adult cancer survivors: A report from the International Late Effects of Childhood Cancer Guideline Harmonization Group. Pediatr Blood Cancer 60:543-549, 2013
18. Mulder RL, Kremer LC, Hudson MM, et al: Recommendations for breast cancer surveillance for female survivors of childhood, adolescent, and young adult cancer given chest radiation: A report from the International Late Effects of Childhood Cancer Guideline Harmonization Group. Lancet Oncol 14:e621-e629, 2013
19. Atkins D, Best D, Briss PA, et al: Grading quality of evidence and strength of recommendations. BMJ 328:1490, 2004
20. Alonso-Coello P, Oxman AD, Moberg J, et al: GRADE Evidence to Decision (EtD) frameworks: A systematic and transparent approach to making well informed healthcare choices. 2: Clinical practice guidelines. BMJ 353:i2089, 2016
21. Gibbons RJ, Smith SC, Antman E, et al: American College of Cardiology American Heart Association clinical practice guidelines: Part II—Evolutionary changes in a continuous quality improvement project. Circulation 107:3101-3107, 2003
22. van Ravesteyn NT, Miglioretti DL, Stout NK, et al: Tipping the balance of benefits and harms to favor screening mammography starting at age 40 years: A comparative modeling study of risk. Ann Intern Med 156:609-617, 2012
23. Nationaal Borstkanker Overleg Nederland (NABON): Guideline Breast Cancer (Richtlijn Borstkanker). 2023. https://richtlijnendatabase.nl/richtlijn/borstkanker/startpagina_-_borstkanker.html
24. American Cancer Society: American Cancer Society Recommendations for the Early Detection of Breast Cancer. 2023. https://www.cancer.org/cancer/types/breast-cancer/screening-tests-and-early-detection/american-cancer-society-recommendations-for-the-early-detection-of-breast-cancer.html
25. Qin N, Wang Z, Liu Q, et al: Pathogenic germline mutations in DNA repair genes in combination with cancer treatment exposures and risk of subsequent neoplasms among long-term survivors of childhood cancer. J Clin Oncol 38:2728-2740, 2020
26. Moskowitz CS, Ronckers CM, Chou JF, et al: Development and validation of a breast cancer risk prediction model for childhood cancer survivors treated with chest radiation: A report from the Childhood Cancer Survivor Study and the Dutch Hodgkin late effects and LATER cohorts. J Clin Oncol 39:3012-3021, 2021
27. Turcotte LM, Liu Q, Yasui Y, et al: Chemotherapy and risk of subsequent malignant neoplasms in the Childhood Cancer Survivor Study cohort. J Clin Oncol 37:3310-3319, 2019
28. Nicholson WK, Silverstein M, Wong JB, et al: Preventive services task force. Screening for breast cancer: US preventive services task force recommendation statement. JAMA. 331:1918-1930, 2024
29. Oeffinger KC, Fontham ETH, Etzioni R, et al: Breast cancer screening for women at average risk 2015 guideline update from the American Cancer Society. JAMA 314:1599-1614, 2015
30. Henderson TO, Amsterdam A, Bhatia S, et al: Systematic review: Surveillance for breast cancer in women treated with chest radiation for childhood, adolescent, or young adult cancer. Ann Intern Med 152:444-455; W144-54, 2010
31. Sanna G, Lorizzo K, Rotmensz N, et al: Breast cancer in Hodgkin's disease and non-Hodgkin's lymphoma survivors. Ann Oncol 18:288-292, 2007
32. Independent UK Panel on Breast Cancer Screening: The benefits and harms of breast cancer screening: An independent review. Lancet 380:1778-1786, 2012
33. Duffy SW, Tabar L, Yen AM, et al: Mammography screening reduces rates of advanced and fatal breast cancers: Results in 549,091 women. Cancer 126:2971-2979, 2020
34. Saadatmand S, Bretveld R, Siesling S, et al: Influence of tumour stage at breast cancer detection on survival in modern times: Population based study in 173,797 patients. BMJ 351:h4901, 2015
35. Yeh JM, Lowry KP, Schechter CB, et al: Breast cancer screening among childhood cancer survivors treated without chest radiation: Clinical benefits and cost-effectiveness. J Natl Cancer Inst 114: 235-244, 2022
36. National Institue for Health and Care Excellence (NICE): Familial breast cancer: Classification, care and managing breast cancer and related risks in people with a family history of breast cancer clinical guideline [CG164]. 2023. https://www.nice.org.uk/guidance/cg164/ifp/chapter/Early-detection-of-breast-cancer-by-surveillance#ftn.footnote_1
37. van der Zanden SY, Qiao X, Neefjes J: New insights into the activities and toxicities of the old anticancer drug doxorubicin. FEBS J 288:6095-6111, 2021
38. Bucclarelli E: Mammary tumor induction in male and female Sprague-Dawley rats by adriamycin and daunomycin. J Natl Cancer Inst 66:81-84, 1981
39. Solcia E, Ballerini L, Bellini O, et al: Mammary tumors induced in rats by adriamycin and daunomycin. Cancer Res 38:1444-1446, 1978

AUTHORS' DISCLOSURES OF POTENTIAL CONFLICTS OF INTEREST

International Guideline Harmonization Group Recommendations for Breast Cancer Surveillance in Childhood, Adolescent, and Young Adult Cancer Survivors After Anthracyclines

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APPENDIX

TABLE A1. Breast Cancer Surveillance Guideline Panel

Name	Country	Area of Expertise	Role
Core leadership group			
Kevin Oeffinger	United States	Oncology primary care	Co-chair
Leontien Kremer	The Netherlands	Guideline methodology	Co-chair
Renée Mulder	The Netherlands	Guideline methodology	Coordinator
Elvira van Dalen	The Netherlands	Epidemiology/guideline methodology	Coordinator
Melissa Hudson	United States	Pediatric Oncology	Advisor
Roderick Skinner	United Kingdom	Pediatric Oncology	Advisor
Expert panel			
Louis Constine	United States	Radiation Oncology	Member
Smita Bhatia	United States	Pediatric Oncology	Member
Wendy Landier	United States	Pediatric Oncology	Member
Gill Levitt	United Kingdom	Pediatric Oncology	Member
Hamish Wallace	United Kingdom	Pediatric Oncology	Member
Flora van Leeuwen	The Netherlands	Epidemiology	Member
Cécile Ronckers	Germany	Epidemiology	Member
Tara Henderson	United States	Pediatrics	Member
Chaya Moskowitz	United States	Epidemiology	Member
Danielle Friedman	United States	Pediatrics	Member
Andrea Ng	United States	Radiation Oncology	Member
Helen Jenkinson	United Kingdom	Pediatric Oncology	Member
Charlotte Demoor-Goldschmidt	France	Radiation Oncology	Member
Dana Barnea	Israel	General Practitioner	Member
Matt Ehrhardt	United States	Pediatric Oncology	Member
Jop Teepen	The Netherlands	Epidemiology	Member
Jorrit van As	The Netherlands	Systematic review methodology	Member
Helena van der Pal	The Netherlands	Internal Medicine	Member
Jennifer Yeh	United States	Epidemiology	Member