

Underutilization of Supplemental Magnetic Resonance Imaging Screening Among Patients at High Breast Cancer Risk

Randy Miles, MD, MPH,¹ Fei Wan, PhD,² Tracy L. Onega, PhD, MA, MS,³
Amanda Lenderink-Carpenter, MD,⁴ Ellen S. O'Meara, PhD,² Weiwei Zhu, MS,²
Louise M. Henderson, PhD,⁵ Jennifer S. Haas, MD, MSc,⁶ Deirdre A. Hill, PhD, MPH,⁷
Anna N.A. Tosteson, ScD,³ Karen J. Wernli, PhD, MS,² Jennifer Alford-Teaster, MA, MPH,³
Janie M. Lee, MD, MSc,⁸ Constance D. Lehman, MD, PhD,⁹ and Christoph I. Lee, MD, MS¹⁰

Abstract

Background: Women at high lifetime breast cancer risk may benefit from supplemental breast magnetic resonance imaging (MRI) screening, in addition to routine mammography screening for earlier cancer detection.

Materials and Methods: We performed a cross-sectional study of 422,406 women undergoing routine mammography screening across 86 Breast Cancer Surveillance Consortium (BCSC) facilities during calendar year 2012. We determined availability and use of on-site screening breast MRI services based on woman-level characteristics, including >20% lifetime absolute risk using the National Cancer Institute risk assessment tool. Multivariate analyses were performed to determine sociodemographic characteristics associated with on-site screening MRI use.

Results: Overall, 43.9% (2403/5468) of women at high lifetime risk attended a facility with on-site breast MRI screening availability. However, only 6.6% (158/2403) of high-risk women obtained breast MRI screening within a 2-year window of their screening mammogram. Patient factors associated with on-site MRI screening use included younger (<40 years) age (odds ratio [OR] = 2.39, 95% confidence interval [CI]: 1.34–4.21), family history (OR = 1.72, 95% CI: 1.13–2.63), prior breast biopsy (OR = 2.09, 95% CI: 1.22–3.58), and postsecondary education (OR = 2.22, 95% CI: 1.04–4.74).

Conclusions: While nearly half of women at high lifetime breast cancer risk undergo routine screening mammography at a facility with on-site breast MRI availability, supplemental breast MRI remains widely underutilized among those who may benefit from earlier cancer detection. Future studies should evaluate whether other enabling factors such as formal risk assessment and patient awareness of high lifetime breast cancer risk can mitigate the underutilization of supplemental screening breast MRI.

Keywords: breast cancer, high-risk screening, supplemental breast MRI, access, disparities

¹Department of Radiology, Massachusetts General Hospital, Harvard Medical School, Boston, Massachusetts.

²Kaiser Permanente Washington Health Research Institute, Seattle, Washington.

³Dartmouth Institute for Health Policy and Clinical Practice, Norris Cotton Cancer Center, Geisel School of Medicine, Lebanon, New Hampshire.

⁴Fort Collins Radiologic Associates, PC, Fort Collins, Colorado.

⁵Department of Radiology, University of North Carolina, Chapel Hill, Chapel Hill, North Carolina.

⁶Department of Medicine, Brigham and Women's Hospital, Harvard Medical School, Boston, Massachusetts.

⁷Department of Internal Medicine, University of New Mexico, Albuquerque, New Mexico.

⁸Department of Radiology, University of Washington School of Medicine, Seattle, Washington.

⁹Department of Radiology, Massachusetts General Hospital, Harvard Medical School, Boston, Massachusetts.

¹⁰Department of Radiology, University of Washington School of Medicine; Department of Health Services, University of Washington School of Public Health; Hutchinson Institute for Cancer Outcomes Research, Seattle, Washington.

Introduction

WHILE MAMMOGRAPHY IS the only modality proven to reduce breast cancer-specific mortality, it demonstrates reduced performance in certain subpopulations of women at increased risk.^{1–6} Improved early cancer detection has been demonstrated among high-risk women who undergo breast magnetic resonance imaging (MRI) screening, in addition to routine mammography screening.^{7–9} Compared to mammography alone, supplemental breast MRI increases sensitivity of screening for detecting smaller, node negative tumors.¹⁰

Early detection of potentially curable cancers is of particular interest among high-risk women, whose cancers develop at an earlier age, grow at a more rapid rate, and have diminished response to therapy compared to women at average risk.^{11–15} As a result, several national organizations, including the National Comprehensive Cancer Network (NCCN), American Cancer Society (ACS), and Society of Breast Imaging (SBI)/American College of Radiology (ACR), support supplemental breast MRI screening in women at high (>20%) lifetime risk.^{16–18}

High-risk screening represents the second most common clinical indication for breast MRI use after presurgical extent of disease workup for newly diagnosed breast cancer patients, and accounts for nearly one-third of breast MRI examinations performed.¹⁹ Although national organization recommendations have helped to facilitate a 20-fold increase in screening breast MRI use over the past two decades, the few reports regarding utilization rates suggest that only a small proportion of high-risk women actually obtain supplemental breast MRI screening.²⁰

Reasons for underutilization of supplemental breast MRI among high-risk patients are currently uncertain, and the availability of on-site breast MRI has been suggested as a potential determinant for screening MRI access and utilization.²¹ Imaging facilities offering on-site breast MRI may mitigate potential barriers to utilization, including increased time constraints and financial costs resulting from women having to identify additional facilities for services beyond mammography. It remains unclear, however, whether women at high lifetime breast cancer risk already attend facilities offering on-site screening MRI and how patient characteristics influence on-site breast MRI use. Thus, our study objectives were to determine the availability of on-site supplemental MRI screening among U.S. women at high risk, who undergo routine mammography, and evaluate clinical and socio-demographic characteristics associated with on-site MRI use.

Materials and Methods

Study setting and population

We conducted a cross-sectional study of all women who obtained a screening mammogram in 2012 at imaging facilities included in the National Cancer Institute-funded Breast Cancer Surveillance Consortium (BCSC), the largest data resource on breast cancer screening in the United States composed of a network of regional registries. We analyzed pooled woman- and facility-level data sent to the BCSC Statistical Coordinating Center (SCC) from six registries (New Hampshire, North Carolina, San Francisco, Vermont, Western Washington, and Chicago). Each registry and the SCC received institutional review board approval for either active or passive

consenting processes or a waiver of consent to enroll individual women, link data, and perform analytic studies. All procedures were Health Insurance Portability and Accountability Act (HIPAA) compliant, and each registry and the SCC received federal certificates of confidentiality and other protections for the identities of individual women.

Facility characteristics

Each of the six registries obtained data from their respective imaging facilities that offer screening mammography, including data regarding the availability of on-site breast MRI. Individual facilities reported their academic medical center affiliation, for-profit versus not-for-profit status, and practice type. For practice type, BCSC facilities were categorized as multispecialty breast center, full diagnostic radiology practice, radiology practice limited to breast, or non-radiology practice. We defined a multispecialty breast center as a facility that is part of an integrated care center with on-site breast-specific specialists, in addition to radiologists (*e.g.*, breast oncologists, surgeons). We defined a full diagnostic radiology practice as a facility that offers imaging services for multiple anatomic body parts beyond the breast. We defined a radiology practice limited to breast as a facility that offers only breast-specific imaging services. We defined a non-radiology practice as a facility located within and operated by a different specialty (*e.g.*, obstetrician-gynecologist practice). Urban–rural classification of facilities was geocoded based on each facility's zip code.

Patient characteristics

Woman-level clinical and sociodemographic data, including age, race/ethnicity, education level, family history, and prior breast biopsy, were recorded for each mammography examination performed in the BCSC from January 1, 2012 to December 31, 2012. For women attending a facility with breast MRI capabilities, we recorded whether or not they obtained on-site screening breast MRI up to 1 year before and 1 year after their screening mammography date. Women were considered to have a strong family history if they had a first-degree relative (mother, sister, or daughter) who was diagnosed with breast cancer. Geocoded linkages between residential zip codes and 2010 Census block-level data were used to assign each woman a median household income and travel time to facility. Low median household income was considered $\leq \$37,686$ based on 2000 Census data.²²

Lifetime breast cancer risk was determined from data collected at the time of mammography screening commensurate with the National Cancer Institute's Breast Cancer Risk Assessment Tool, including women's age at menarche, age at first birth, personal history of benign breast biopsies and of atypical hyperplasia, and family history of breast cancer. Women with personal history of breast cancer were excluded from the analysis. On-site breast MRI use was recorded from BCSC registry data for patients at high lifetime risk, defined as >20%.¹⁶

Statistical analysis

We report the descriptive statistics of all BCSC facility characteristics and all women attending BCSC facilities in 2012. We identified associations between the use of on-site supplemental MRI and patient characteristics for women with high lifetime risk of breast cancer of >20% using Pearson's

chi-square tests. We used multivariable logistic regression to assess the effects of patient characteristics on the use of on-site supplemental MRI among women with a high lifetime risk. Variable selection was based on likelihood ratio tests. The final model included age, family history, previous biopsy, and educational level. Generalized estimating equations were used in our logistic regression model to address the correlation among women attending the same BCSC facility. We report odds ratios (ORs) and 95% confidence intervals (CIs) based on robust standard errors. All statistical analyses were performed using SAS version 9.3 (SAS Institute, Cary, NC). Statistical significance was set at $p \leq 0.05$, and all tests were two-tailed.

Results

We acquired data from 86 breast imaging facilities affiliated with 6 regional BCSC registries. Of these, 74.4% (64/86) were located in urban settings, 22.1% (19/86) were located in rural settings, and 3.5% (3/86) were of unknown rural/urban status. The majority of facilities was not-for-profit (60.5%, 52/86) and

not affiliated with an academic institution (94.2%, 81/86). Most imaging facilities represented full diagnostic radiology practices (58.1%, 50/86), followed by radiology practices limited to breast imaging (19.8%, 17/86), multispecialty breast centers (18.6%, 16/86), and non-radiology practices (3.5%, 3/86). Nearly one-third of facilities (30.2%, 26/86) offered on-site supplemental screening MRI. While about two-thirds of multispecialty breast centers (68.8%, 11/16) and about one-third of full diagnostic radiology practices (30% 15/50) had MRI screening capabilities, none of the radiology practices limited to breast imaging or non-radiology practices offered this service.

A total of 422,406 screening mammograms were performed at BCSC facilities in 2012. Of these exams, 44.5% (188,069/422,406) were performed at a facility with on-site breast MRI screening. Characteristics of patients attending a facility with on-site breast MRI screening are shown in Table 1. Patients receiving mammography at a site with MRI services were largely older (ages 50–74; 63.8%, 119,964/188,069), white (68.9%, 129,505/188,069), and college graduates (32.5%, 61,197/188,069). Similar rates of on-site MRI

TABLE 1. CHARACTERISTICS OF WOMEN UNDERGOING BREAST CANCER SCREENING

Woman characteristics	Category	All patients, N (%)	Patients attending a facility with on-site MRI, N (%)	Patients not attending a facility with on-site MRI, N (%)
		Total, n = 422,406	Total, n = 188,069	Total, n = 234,337
Age (years)	<40	5947 (1.4)	3286 (1.7)	2661 (1.1)
	40–49	101,633 (24.1)	46,862 (24.9)	54,771 (23.4)
	50–74	273,948 (64.9)	119,964 (63.8)	153,984 (65.7)
	>74	40,878 (9.7)	17,957 (9.5)	22,921 (9.8)
Race/ethnicity	White	269,971 (63.9)	129,505 (68.9)	140,466 (59.9)
	Black	47,561 (11.3)	18,676 (9.9)	28,885 (12.3)
	Asian	49,123 (11.6)	22,521 (12.0)	26,602 (11.4)
	Hispanic	26,293 (6.2)	10,066 (5.4)	16,227 (6.9)
	Other	9164 (2.2)	4371 (2.3)	4793 (2.0)
Family history	Unknown	20,294 (4.8)	2929 (1.6)	17,365 (7.4)
	No	333,425 (78.9)	148,151 (78.8)	185,274 (79.1)
Prior breast biopsy	Yes	69,909 (16.6)	31,837 (16.9)	38,072 (16.2)
	Unknown	19,072 (4.5)	8081 (4.3)	10,991 (4.7)
Low household income	No	321,368 (76.1)	139,630 (74.2)	181,738 (77.6)
	Yes	97,840 (23.2)	47,273 (25.1)	50,567 (21.6)
	Unknown	3198 (0.8)	1166 (0.6)	2032 (0.9)
Education level	No	357,649 (84.7)	155,221 (82.5)	202,428 (86.4)
	Yes	30,082 (7.1)	12,199 (6.5)	17,883 (7.6)
	Unknown	34,675 (8.2)	20,649 (11.0)	14,026 (6.0)
Travel time to facility	Less than high school	19,535 (4.6)	8280 (4.4)	11,255 (4.8)
	High school	50,402 (11.9)	20,993 (11.2)	29,409 (12.5)
	Some college	67,143 (15.9)	29,122 (15.5)	38,021 (16.2)
	Greater than or equal to college	131,587 (31.2)	61,197 (32.5)	70,390 (30.0)
	Unknown	153,739 (36.4)	68,477 (36.4)	85,262 (36.4)
High lifetime risk	<15 minutes	34,577 (8.2)	10,452 (5.6)	24,125 (10.3)
	15–30 minutes	209,781 (49.7)	104,310 (55.5)	105,471 (45.0)
	30–60 minutes	80,017 (18.9)	36,301 (19.3)	43,716 (18.7)
	>60 minutes	98,031 (23.2)	37,006 (19.7)	61,025 (26.0)
High lifetime risk	No	411,111 (97.3)	182,880 (97.2)	228,231 (97.4)
	Yes	5468 (1.3)	2403 (1.3)	3065 (1.3)
	Unknown	5827 (1.4)	2786 (1.5)	3041 (1.3)

MRI, magnetic resonance imaging.

TABLE 2. ASSOCIATIONS BETWEEN CHARACTERISTICS OF WOMEN AT HIGH (>20%) LIFETIME RISK ATTENDING FACILITIES OFFERING SCREENING MAGNETIC RESONANCE IMAGING AND ACTUAL USE OF SCREENING MAGNETIC RESONANCE IMAGING

Patient characteristics	Category	MRI screening, N (%)		p
		Total, n=158	Total, n=2245	
Age (years)	<40	13 (8.2)	102 (4.5)	0.05
	40–49	47 (29.7)	586 (26.1)	
	50–74	98 (62.0)	1543 (68.7)	
	>74	0 (0.0)	14 (0.6)	
Race/ethnicity	White	146 (92.4)	2046 (91.1)	0.72
	Black	0 (0.0)	17 (0.8)	
	Asian	2 (1.3)	44 (2.0)	
	Hispanic	5 (3.2)	51 (2.3)	
	Other	5 (3.2)	72 (3.2)	
	Unknown	0 (0.0)	15 (0.7)	
Family history	No	13 (8.2)	259 (11.5)	0.20
	Yes	145 (91.8)	1982 (88.3)	
	Unknown	0 (0.0)	4 (0.2)	
Prior breast biopsy	No	29 (18.4)	654 (29.1)	<0.01
	Yes	129 (81.6)	1581 (70.4)	
	Unknown	0 (0.0)	10 (0.4)	
Low household income	No	136 (86.1)	1953 (87.0)	0.42
	Yes	7 (4.4)	138 (6.1)	
	Unknown	15 (9.5)	154 (6.9)	
Education level	Less than high school	0 (0.0)	55 (2.4)	0.01
	High school	14 (8.9)	315 (14.0)	
	Some college	42 (26.6)	482 (21.5)	
	Greater than or equal to college	98 (62.0)	1045 (46.5)	
	Unknown	4 (2.5)	348 (15.5)	
Travel time to facility	<15 minutes	6 (3.8)	106 (4.7)	0.04
	15–30 minutes	82 (51.9)	1087 (48.4)	
	30–60 minutes	13 (8.2)	368 (16.4)	
	>60 minutes	57 (36.1)	684 (30.5)	

screening availability were experienced by patients undergoing mammography with low (40.6%, 12,199/30,082) and high (43.4%, 155,221/357,649) household incomes. Patients experiencing longer (>60 minutes) travel times to screening facilities (37.7%, 37,006/98,031) demonstrated lower rates of on-site MRI attendance compared to patients living in close (15–30 minutes) proximity (49.7%, 104,310/209,781). Overall, 43.9% (2403/5468) of women at high lifetime risk attended facilities with on-site supplemental MRI screening.

Patient characteristics associated with receipt of on-site breast MRI among high-risk women are shown in Table 2. Only 6.6% (158/2403) patients at high lifetime risk attending facilities offering on-site MRI underwent supplemental MRI screening within a year before and a year after their routine mammogram. Of patients with high lifetime risk, a majority were older (ages 50–74; 62.0%, 98/158), white (92.4%, 146/158), and college educated (62.0%, 98/158). High-risk patients demonstrating longer travel times (>60 minutes) to screening facilities underwent on-site breast MRI less often than patients living at closer proximity to screening facilities.

In multivariate analysis of factors associated with supplemental MRI use in women at high lifetime risk (Table 3), significant sociodemographic factors included age (<40 years), family history, prior breast biopsy, and postsecondary educa-

tion (greater than or equal to some college). Women younger than 40 years were more likely to undergo on-site MRI screening than older women (OR = 2.39, 95% CI: 1.36–4.21). Patients with strong family history (OR = 1.72, 95% CI: 1.13–2.63) and prior breast biopsy (OR = 2.09, 95% CI: 1.22–3.58) were also more likely to undergo on-site MRI screening

TABLE 3. MULTIVARIATE ANALYSIS OF ON-SITE SUPPLEMENTAL MAGNETIC RESONANCE IMAGING USE IN WOMEN AT HIGH (>20%) LIFETIME RISK OF BREAST CANCER

Woman characteristics	Category	Odds ratio (95% CI)
Age (years)	<40	2.39 (1.36–4.21)
	40–49	1.41 (0.97–2.03)
	≥50	Reference
Family history	Yes	1.72 (1.13–2.63)
	No	Reference
Prior breast biopsy	Yes	2.09 (1.22–3.58)
	No	Reference
Postsecondary education	Yes	2.22 (1.04–4.74)
	No	Reference

CI, confidence interval.

compared to respective patients without these characteristics. On-site supplemental MRI screening was also positively associated with advanced educational attainment compared to women without postsecondary education (OR = 2.22, 95% CI: 1.04–4.741).

Discussion

While nearly half of high-risk women attended a facility for screening mammography that also offered on-site breast MRI screening in 2012, similar to the attendance rate of the overall general screening population, actual use of on-site supplemental MRI was low. Only 6.6% of patients at high lifetime risk underwent screening breast MRI in our study. Our results corroborate suggestions of screening MRI underuse reported in previous studies, even when considering on-site MRI availability.

Previously, Wernli et al. demonstrated low screening breast MRI use among an earlier cohort (2005–2009) of patients with high lifetime risk in community practice.¹⁹ Similarly, Miller found that breast MRI uptake was <5% based on self-reported data in a nationally representative sample of women, despite including breast MRI examinations performed for all clinical indications.²⁰ In the context of these prior analyses, our findings suggest that on-site availability at screening facilities likely does not alleviate screening MRI underuse.

Differential on-site MRI screening use was seen in certain subgroups of high-risk women. Characteristics associated with MRI use among women with high lifetime risk included younger age (<40 years), prior breast biopsy, postsecondary education, and shorter (<30 minutes) travel time to facility. In multivariate analysis, strong family history was also associated with on-site MRI use among women at high lifetime risk.

Greater worry about breast cancer risk seen in younger populations and longer remaining life expectancy may act as drivers for increased utilization among younger women compared to women older than 40 years.²³ In addition, Brinton demonstrated that radiologists were more likely to recommend supplemental MRI screening in patients younger than 40 years compared to older patients, potentially triggering providers to order breast MRI at increased rates for younger women.²⁴ An increased utilization in patients with prior breast biopsy may reflect an increased exposure to advanced breast imaging services and heightened awareness of breast cancer risk.

Our study builds on findings by Haas et al.,²⁵ who reported a positive association between advanced education and uptake of supplemental MRI screening services over time. Higher educational attainment may increase personal perception of risk based on family history, which may encourage women in this group to discuss risk reduction with healthcare providers.²⁵ Prior studies have also suggested disparities among traditionally underserved groups in gaining access to genetic risk assessment, which may directly impact referral for supplemental breast screening.²⁶ We found no significant difference in on-site MRI use between women who resided in areas with low household income levels compared to women with higher income levels. Additional reported barriers to supplemental screening include lack of a primary care provider, lack of health insurance, associated out-of-pocket costs, anxiety related to MRI exams, and lack of social support, although these factors were not assessed in our study.²⁷

Multispecialty breast centers and full diagnostic radiology practices represented the most common practice types to offer breast MRI screening, reflecting their propensity for early adoption of advanced imaging modalities for new indications such as screening.²⁶ Most facilities offering supplemental MRI screening were also located in urban settings. This, in addition to low availability of on-site MRI screening services for patients living >30 minutes from their screening facility, supports previously described geographic access barriers to breast MRI among rural patients.^{28–32}

Prior studies have suggested that increasing physician time constraints and lack of provider familiarity with genetic risk assessment tools, both contribute to barriers for improved breast cancer screening and risk reduction measures.^{33–35} Misperception of breast cancer risk by both physicians and patients may also partially explain overall low utilization. Provider overreliance on family history in recommending advanced imaging was suggested by Wernli et al., who showed that only 25% of patients undergoing high-risk MRI screening met ACS criteria.¹⁹ Moreover, it has been demonstrated that a majority of high-risk women underestimate their risk, while average-risk women overestimate their risk, potentially influencing patient pursuit of supplemental screening.³⁶

Our study had several strengths, including the analysis of a large, diverse patient population associated with a geographically diverse set of imaging facilities. Compared to Haas, who looked at overall breast MRI utilization patterns over time, we provide an updated analysis using an expanded number of facilities aimed at determining the effect of on-site screening breast MRI availability on breast MRI screening utilization rates among high-risk women. Our study also had several limitations. We did not have data from non-BCSC facilities that may have provided supplemental screening services for facilities without on-site breast MRI availability. It is difficult to ascertain whether additional women would have been classified as high risk based on more comprehensive risk models, specifically those named in the ACS guidelines, including BRCAPRO, Boadicea, and Tyrer-Cuzick risk models. Information collected at the time of imaging was insufficient for calculating risk assessment using these newer models. Despite this limitation, the Gail model is the oldest and most widely available tool for breast cancer risk assessment; therefore, use of this model may more closely reflect current practice for risk-based MRI screening.

Conclusions

In summary, we observed that nearly one-third of U.S. community-based screening facilities included in our study have on-site breast MRI capability and nearly one-half of the high-risk women attended a facility offering on-site screening breast MRI. However, despite its widespread availability, use of supplemental screening breast MRI remains low among women classified as having high lifetime risk. A better understanding of the sociodemographic determinants of breast MRI underuse is needed to guide novel interventions that target high-risk women who may benefit from supplemental screening. Future studies should aim to identify and evaluate novel interventions for increasing use of screening MRI among high-risk women, such as automated lifetime risk calculations included in screening mammography reports.³⁷ Newer technologies such as abbreviated/fast breast

MRI should be examined as lower cost, higher value options that may encourage more high-risk women to undergo supplemental MRI screening. Special attention and heightened awareness in women demonstrating low socioeconomic factors and older age may also be needed to ensure that all women benefit from supplemental screening services.

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Address correspondence to:

Christoph I. Lee, MD, MS

Department of Radiology

University of Washington School of Medicine

825 Eastlake Avenue East, G3-200

Seattle, WA 98109

E-mail: stophlee@uw.edu