Published in final edited form as:

Health Commun. 2018 April ; 33(4): 489–495. doi:10.1080/10410236.2016.1278499.

Informing Women and Their Physicians about Recommendations for Adjunct Breast MRI Screening: A Cohort Study

John T. Brinton^a, Lora D. Barke^b, Mary E. Freivogel^b, Tiffany C. Talley^b, Michelle D. Lexin^b, Alicia L. Drew^b, Rachel B. Beam^b, Deborah H. Glueck^{c,d}

^aDepartment of Biostatistics and Informatics, Colorado School of Public Health

^bRadiology Imaging Associates and Invision Sally Jobe Breast Centers

^cDepartment of Biostatistics and Informatics, Colorado School of Public Health

^dDepartment of Radiology, University of Colorado School of Medicine

Abstract

It is unclear how best to communicate recommendations for breast cancer screening with MRI as an adjunct to mammography for women at high risk. This study compares the rates of breast MRI screening for two different methods of communication. The retrospective IRB-approved cohort study was conducted at Invision Sally Jobe Breast Centers (ISJBC). ISJBC provided Gail model risk assessment to all women presenting for screening mammography. Women with scores 19.6% were considered to be high risk. Over 2 years, ISJBC used two different methods to inform women at elevated lifetime risk and their physicians about recommendations for adjunct MRI screening ($N = 561$, mean age = 52 years, s.d. = 8.7). During Window A, information was sent to referring physicians as a part of the dictated imaging report, while later, in Window B, the information was sent to referring physicians as well as to the women themselves in a letter. Analyses were stratified by mammography screening frequency. One-time screeners presented in only Window A or Window B. Repeat screeners came both in Window A and in Window B. Breast MRI screening rates were significantly higher in Window B than in Window A (one-time screeners, $N = 459$, 9.8% vs. 14.4%, $p = 0.047$; repeat screeners, $N = 102$, 0% vs. 6.9%, $p = 0.016$). Although an observational study cannot assess causality, direct communication of risk-based recommendations for adjunct breast MRI screening to women and to their referring physicians was associated with an increased rate of screening breast MRI completion at the same clinic at which the women underwent mammography.

Introduction

Multiple organizations have issued recommendations for adjusting the choice of breast cancer screening using estimated lifetime risk of breast cancer. In 2007, the American Cancer Society (ACS) issued guidelines recommending that women at elevated (20–25%)

lifetime risk for breast cancer be screened with breast MRI as an adjunct to mammography (Saslow et al., 2007). The National Comprehensive Cancer Network (NCCN) recommends adjunct screening based on estimated lifetime risk (Bevers et al., 2015).

Much attention has been paid to assessing the efficacy of breast MRI screening (Berg et al., 2012; Raikhlin et al., 2015; Saadatmand et al., 2015; Warner et al., 2011), the cost-effectiveness of MRI screening (Saadatmand et al., 2013), possible overdiagnosis (Narod, Iqbal, Giannakeas, Sopik, & Sun, 2015), and screening in women at high risk (Bevers et al., 2015). However, little attention has been paid to communicating risk and screening recommendations to women. Communication is important, as uptake of screening breast MRI is low among women at high risk (Brinton et al., 2012).

A literature review was conducted to explore whether any other study had evaluated methods for implementing a risk-based screening program like that suggested in the ACS guidelines (Saslow et al., 2007). The literature review included the 738 peer-reviewed published manuscripts that cited Saslow et al. (2007) which appeared in a Web of Science citation report conducted on August 27, 2015.

Not one of the papers we reviewed evaluated implementation methods for risk-based screening in a large community population. Three authors examined rationale for MRI and use of MRI. Miller et al. (2013) evaluated data from women who responded to questions about having a breast MRI on the 2010 National Health Interview Survey (Miller et al., 2013) and noted that less than half of the women who reported having a breast MRI were at increased risk. Ehsani et al. (2015) noted that 88% of women with increased risk for breast cancer underwent screening breast MRI in addition to mammography. Hollingsworth and Stough (2014) suggested an alternative approach to selecting patients for high-risk screening with breast MRI but did not discuss the rate of uptake of MRI among women who received a recommendation for MRI as a result of being at high risk.

There is a gap in the literature about how best to communicate recommendations for risk-based breast cancer screening. An opportunity to study methods of implementation was created by a shift in practice at Invision Sally Jobe Breast Centers (ISJBC), a high-volume private practice in the Denver metropolitan area. The change in practice at Invision Sally Jobe Breast Centers created a natural nonrandomized intervention study. Before November 2009, ISJBC provided risk assessment to all women presenting for breast cancer screening and included a paragraph in the mammography report sent to the women's physician if the woman was at high risk, and an MRI was indicated. After November 2010, ISJBC provided a letter to the woman herself with this information, in addition to including the results in the mammography report.

The objective of this study was to compare the rates of breast MRI screening completion for the two methods of communication. Measuring the rate of breast MRI completion in both time periods gives a comparison of the utility of the two practice approaches.

Methods

The study was a historical cohort study, approved by the HCA-HealthONE IRB. Participants were drawn from all women presenting for breast screening at Invision Sally Jobe Breast Centers during Window A, November, 2009 to April, 2010, and/or Window B, November, 2010 to April, 2011. At the time of the screening visit, each woman's lifetime risk of breast cancer (up to the age of 90 years) was assessed via the Gail model (Decarli et al., 2006; Gail et al., 1989). All women who had a Gail score of $\geq 19.6\%$ were considered to be at elevated lifetime risk. We note that using the Gail model does not follow the ACS recommendations. Saslow et al. suggested using a model that depends on family history, like the BRCAPRO (Berry et al., 2002), Tyrer-Cuzick (Tyrer, Duffy, & Cuzick, 2004), or Claus models (Claus, 2000).

For women at high risk according to the Gail model, the clinic generated a paragraph explaining that the woman's risk of breast cancer had been assessed, and indicating that based on the risk, the woman was a candidate for breast MRI screening (an example paragraph appears in Appendix A). The paragraph discussed the ACS guidelines for adjunct MRI. The letter did not mention what the woman's risk score was, nor indicate that the woman was at high risk.

In Window A, this paragraph was sent only to the referring physicians as a part of the imaging report. In Window B, the paragraph was sent to the referring physicians. Separate letters were also sent to the women directly. The letters suggested that based on the medical history information provided, the patient may want to schedule a visit with their referring doctor(s) to discuss breast MRI. An example letter appears in Appendix B. The two communication processes are shown in Figure 1.

De-identified imaging reports (Mammography Reporting System Incorporated, Lynnwood, Washington, USA) were used to determine the percentage of women completing screening breast MRI at Invision Sally Jobe Breast Centers.

Follow-up time varied for each woman. Completion of the screening breast MRI was confirmed if the imaging record indicated a screening breast MRI procedure at any time between the date of the initial screening mammogram and the next observed screening mammogram. The study did not follow women to determine whether they had a screening breast MRI at another clinic or were otherwise lost to follow-up.

Inclusion/exclusion

Women were included in the study if they presented for screening mammography during either study window and were 35 years of age or older. Women were included if they had $\geq 19.6\%$ lifetime risk on the Gail model, under the assumption that Gail scores were rounded to the nearest whole number.

Reports included mammography Breast Imaging Reporting and Data System (BI-RADS) assessments associated with each screening visit (D'Orsi et al., 2003). Only women with a mammography BI-RADS assessment of 1 (negative), or 2 (benign), on the current and the

most recent prior screening mammography were included. Women were excluded if the imaging record showed: 1) a diagnosis of breast cancer in the year before the mammography visit, 2) a MRI on the same day as the screening mammography, or 3) a history of past MRI screenings within 1 year of the screening mammogram. Inclusion and exclusion criteria were verified by examining each patient's de-identified imaging report.

Data collection

In Window A, data were collected until all records for women meeting the inclusion criteria had been obtained. In Window B, records for 507 women were collected, at which time the funding for data collection ended. The data, abstracted from the electronic screening reports, included age at screening visit, date of screening visit, Gail score at screening visit, and mammography BI-RADS assessment.

Recommendation verification

Study staff reviewed the mammography report sent to the referring physician to confirm that the recommendation paragraph appeared. The recommendation letter was sent to each woman in a separate envelope sent after their mammography result. Study staff also verified if a recommendation letter had been sent via US mail to the woman's home address.

Risk assessment

During the study period, Invision Sally Jobe Breast Centers assessed each patient's lifetime risk of breast cancer. Risk was assessed by trained and certified radiology technologists who used a two-step process. First, women presenting for screening mammography were asked if they had a first-degree relative with breast cancer. Second, all women who reported a first-degree relative with breast cancer were asked questions as required for input into the National Cancer Institute Breast Cancer Risk Assessment Tool (<http://www.cancer.gov/BCRISKTOOL/>). The technologists calculated risk using the Gail model and then entered the Gail risk score into the electronic medical record. The Gail model (Decarli et al., 2006; Gail et al., 1989) uses as inputs age, age at menarche, age at first live birth, number of first-degree female relatives with breast cancer, number of previous breast biopsies, prior diagnosis with atypical hyperplasia, and race. Race was input as Caucasian unless the woman was African-American.

Statistical analysis

Women who presented for screening mammography only in Windows A or in Window B were classified as one-time screeners. Women who presented for screening mammography both in Window A and in Window B were classified as repeat screeners. Records were cross-classified into four groups based on study window (A or B) and whether women were one-time or repeat screeners. Descriptive analyses including percentages, means, and medians were calculated for each of the four window-by-screening frequency categories. Differences in mean age were evaluated with a Satterthwaite *t*-test. The differences in median Gail score were evaluated with a Wilcoxon rank sum test. Fisher's exact tests were used to test for a difference in proportions between independent records. McNemar's exact

test was used to test for a difference in proportions for paired records (repeat screeners). All tests were two-sided. All analyses were conducted in SAS 9.3 (SAS Institute Inc., 2011).

Results

Records on 561 women with a mean age of 52 (s.d. = 8.7) years were included in the final analysis. In Window A (November, 2009 to April, 2010), there were 31,596 screening examinations. In that time period, 952 women (3.1% of 31,596) were identified as having an elevated lifetime risk of breast cancer. During Window B (November, 2010 to April, 2011), there were 32,332 screening examinations and 935 (2.9% of 32,332) women with an elevated lifetime risk. Due to limited staffing resources, only 857 de-identified imaging reports were reviewed for possible inclusion in the study. After applying all exclusion criteria, 663 records involving 561 women were included in the analysis. There were 153 women who were screened only in Window A and 306 women who were screened only in Window B (one-time screeners). There were 102 women who were screened twice, once in Window A and once in Window B (repeat screeners).

Table 1 compares the ages and Gail scores of repeat screeners and one-time screeners in Windows A and B. For Window A, one-time screeners were not significantly different than repeat screeners in age (Satterthwaite $t = -0.56$, $df = 232$, $p = 0.573$) and Gail score (Wilcoxon rank sum = 13237, $p = 0.754$). For Window B, one-time screeners were not significantly different than repeat screeners in Gail score (Wilcoxon rank sum = 22410, $p = 0.1334$) but were on average 2.6 years younger than repeat screeners (Satterthwaite $t = -2.96$, $df = 187$, $p = 0.0035$). Comparing one-time screeners from Window A and Window B, there was no significant difference in age (Satterthwaite $t = 1.21$, $df = 297$, $p = 0.2271$). Gail scores were significantly higher in Window A than in Window B (Wilcoxon rank sum = 39244, $p = 0.0026$).

In Window A, the frequency of MRI recommendations appearing in the previous year's imaging reports was not different for one-time screeners compared to repeat screeners (Fisher's exact $p = 0.1985$). In Window B, one-time screeners were less likely to have had a recommendation for MRI appear in the previous year's imaging reports (Fisher's exact $p < 0.0001$). Comparing one-time screeners from Window A and Window B, the rate of recommendation for MRI appearing in the previous year's imaging reports was higher in Window A (Fisher's exact $p < 0.0001$).

Table 2 shows the rates of screening breast MRI completion for one-time screeners and repeat screeners, by method of communicating ACS recommendations and by study window. MRI screening rates were significantly higher for women in Window B compared to women in Window A (one-time screeners, Fisher's exact $p = 0.0467$; repeat screeners, exact McNemar's $p = 0.0156$). Repeat screeners had lower rates of MRI completion than one-time screeners in both study windows (Window A, Fisher's exact $p = 0.0005$; Window B, Fisher's exact $p = 0.0563$), but the difference attained significance only in Window A.

Discussion

This study compared the effectiveness of two approaches for communicating recommendations for adjunct breast MRI screening to women with elevated lifetime risk of breast cancer. Both approaches rely on the doctor–patient communication. The first approach relies on the referring physician to communicate the information to the patient in a physician-directed decision-making structure. The second approach, in which a letter is sent to both the woman and the physician, reflects a belief in patient autonomy. This is in line with suggestions from ethicists that physicians shift from “promoting the benefits of screening to providing comprehensive information to enable people to make an informed choice” (Jepson, Hewison, Thompson, & Weller, 2005). Although an observational study cannot assess causality, in this study, direct communication of the recommendation to women, in addition to their referring physicians, was associated with an increased rate of screening breast MRI completion at the same clinic at which the women underwent mammography.

The letter Invision Sally Jobe Breast Centers used was an effort to communicate important information about estimated risk without inciting fear or anxiety or incurring legal liability. The letter that the clinic sent to the women did not state their actual calculated lifetime risk, nor did it explicitly state that they were at high risk for breast cancer. The letter (shown in Appendix B) did not specifically recommend that the woman should seek screening breast MRI.

The study excluded women with a diagnosis of breast cancer in the year before their screening visit. In addition, the exclusion criteria were designed to eliminate women whose motivation to seek breast MRI screening might have been increased because of a recent abnormal result from a screening exam. We excluded women who had an abnormal BI-RADS score in their screening report 1 year prior to their routine screening visit. We reasoned that women with an abnormal mammography result or a current diagnosis of breast cancer may have been motivated to seek MRI for diagnosis, staging, confirmation, or reassurance, and that their decision to seek breast MRI reflected reasons other than the communication method of the clinic.

This study did not specifically evaluate the ACS guidelines for breast MRI screening as an adjunct to mammography. During the study, Invision Sally Jobe Breast Centers used the Gail model, rather than the BRCAPRO, Tyrer–Cuzick, or Claus models recommended by the ACS. The Gail model was not intended to be used to identify candidates for breast MRI screening. In an effort to comply with the American Cancer Society recommendations, ISJBC have now implemented the Tyrer–Cuzick model, which is used for risk assessment for all women presenting for breast cancer screening.

The study has several weaknesses. Because the study was conducted in a single clinic, the study may lack generalizability to other clinics, as well as to other populations. In addition, the study did not evaluate other rationales for breast cancer screening, including the presence of a pathogenic mutation in *BRCA1/2* and breast density. Because the study was a nonrandomized, observational design, the results may have been influenced by trends in

breast MRI usage rather than by the change in notification practice. Wernli et al. (2014) have reviewed patterns of breast MRI usage in community practice. It is interesting to note that the 2009 United States Preventive Services Task Force recommendations for women at average risk of breast cancer were published during the study time period (Nelson et al., 2009). Although the recommendations did not address screening in high-risk women, publicity about delaying the age to begin routine screening mammography may have been influenced the choice of our study population to complete breast MRI screening. We cannot evaluate this effect.

Without concurrent external data on breast MRI usage in other centers, we cannot differentiate between the effect of changing the method of communicating recommendations and any potential effect due to changes in MRI usage over time. This is because in our observational study, the time of observation (Window A vs. Window B) is completely confounded with communication method (communication to physician alone or communication to both woman and physician). In the future, a randomized clinical trial, in which women are randomized to one of the two communication methods within a single time period, would allow for evaluation of the effect of communication method, unconfounded by the time effect. In the proposed trial, we hope to collect information about how often women in either arm contacted their primary care physician, as suggested in the letter, whether they contacted another physician or medical professional, whether they contacted friends and/or family, whether they searched for more information on their own, or whether they asked their trusted advocates to search for them.

Thirdly, because only those women who returned to ISJBC for their screening breast MRI could be counted, the breast MRI rates recorded in the study may have been underestimated. Finally, the study was not able to measure possible faults in the communication stream. For example, we could not observe whether the mammography technologist failed to ask about first-degree relatives nor whether the technologist failed to enter the Gail score.

The study did not evaluate the doctor–patient communication relationship, which is essential to understanding why women might choose to get breast MRI screening. We did not compare the utility of having subspecialists refer women for MRI, rather than their primary care physicians. We did not record or report data from the woman’s perspective. We do not know whether a woman’s referring physician discussed the mammography report with her, whether the letter arrived at the woman’s home, nor whether the woman read and understood the letter. We do not know why a woman chose to act on the recommendations, if, in fact, they received them. We do not know why some women chose to do yearly screening, rather than being screened only once.

Why high-risk women do not undergo recommended breast MRI screening remains an unanswered question. One possible explanation is that women themselves choose to avoid MRI for various reasons. Berg et al. (2010) noted that 42% of women invited to have MRI screening at no out-of-pocket cost declined, citing reasons such as claustrophobia, time, and money. One factor, noted by 9.2% of women who declined, was that “their physician would not provide a referral and/or did not believe MR imaging was indicated.” Finally, it is

possible that the conflicting recommendations about breast cancer screening leave women unsure what recommendations to follow.

One of the major limitations of the study was that we were unable to determine whether women had sought MRI screening at another clinic. The question is whether this lack of follow-up created a substantial bias by differentially affecting MRI rates in the two time periods. Further studies that attempt to measure rates of MRI completion should attempt to consent women and to use direct contact for extended follow-up.

The retrospective study design precluded us from being able to evaluate the doctor–patient communication relationship. Understanding that communication would have been essential to understanding why women might choose to get breast MRI screening. Despite the limitations, we feel that the study remains useful. The study provides the first comparison of two approaches to implementing risk-based screening in practice. It demonstrates the value of communicating directly with the patient versus communicating only with their physician.

The carefully written recommendations included in the Appendices have been through legal, medical, and practical reviews and have now been shown to be associated with a higher rate of screening breast MRI, in women deemed to be at high risk via the Gail model. Other clinics that choose to implement a similar effort are free to use the language, and can have some idea of the expected increase in breast MRI screening exams. In addition, the study provides the first comparison of two approaches to implementing risk-based screening. Like our previous study (Brinton et al., 2012), the current study shows that the rates of completion of breast MRI screening remain low for women at high lifetime risk of breast cancer.

While a significant increase in the rate of breast MRI was noted in this study, improved methods of communicating recommendations for adjunct breast MRI are needed. Approaches which increase adherence may be used to improve breast MRI screening rates. Examples include motivational interviewing, patient navigators, mobile clinics, and more effective educational materials. Our study demonstrates that directly informing women at high lifetime risk of breast cancer about personalized breast cancer screening recommendations is associated with increased rates of breast MRI. While caution should be taken in generalizing our results, it is our hope that the research will be of use to breast imaging facilities, physicians, and women in their endeavors to maximize the efficacy of breast cancer screening.

Acknowledgements

The authors would like to acknowledge the support and technical assistance of Ms. Stacy Jackson.

Funding

The work was supported in part by the Cancer Special Interest Group Grant Award (CSGA) from the National Society of Genetic Counselors.

Appendix A:: Example of paragraph in the mammography report sent to a woman's primary care physician

Based on her lifetime risk for breast cancer, this patient is a candidate for annual breast MRI screening according to the American Cancer Society guidelines (CA Cancer J Clin 2007;57:75–89). Mammography remains the gold standard for breast cancer screening. If breast MRI is pursued, it should be done in addition to (not instead of) screening mammography. Breast MRI screening can be done at the same time as screening mammography or alternating every six months. The patient can discuss this option with the referring physician(s) at the next office visit.

Appendix B:: Example letter sent to each high-risk woman via mail

Dear:

Thank you so much for your recent visit to Invision Sally Jobe Breast Centers. We strive to provide the best and most comprehensive breast care to our patients. As part of your exam at our facility, we completed a personalized assessment of your breast cancer risk. Please note that the information in this letter does not change the results of any recent exam but, rather, provides suggestions for additional measures you may want to consider.

Based on the information you provided to us about your personal and family medical history, you may choose to schedule a visit with your referring doctor(s) to discuss the following.

(The following paragraph “GENETIC CONSULTATION/TESTING” was only included for women who had a family history suggestive of a hereditary breast cancer syndrome, in addition to a lifetime risk of 19.6% or greater, on the Gail model)

GENETIC CONSULTATION/TESTING

Some people inherit genes that make them more likely to get certain types of cancer. Testing is available for some of these genes. A genetic consultation involves meeting with a genetics expert who will review your personal and family history of cancer. He or she will discuss the details of genetic testing with you—and your family if you choose—and help you to make an informed choice about that type of testing. This person will provide you with personalized estimates of your cancer risks which may lead to screening and medical management options that you would not have considered otherwise. These options may allow for early detection and/or prevention of cancer.

BREAST MRI SCREENING

Breast MRI is another way to screen for breast cancer, and it is recommended by the American Cancer Society for certain women depending on their level of risk. Breast MRI screening is recommended annually, in addition to (not instead of) mammograms. Studies have shown that, in these women, using both mammography and breast MRI screening is more effective in early detection of breast cancer when compared to mammography alone.

At Invision Sally Jobe, we believe in empowering women to understand their options when it comes to health and wellness. Understanding your risk for cancer is the first step toward reducing that risk. We are proud to work as a team with you and your referring doctors toward the common goal of early detection and cancer prevention. If you have questions about this letter, do not hesitate to contact us at the phone number below.

Sincerely,

The Risk Assessment and Prevention Program.

References

- Berg WA, Blume JD, Adams AM, Jong RA, Barr RG, Lehrer DE, ... Mendelson EB (2010). Reasons women at elevated risk of breast cancer refuse breast MR imaging screening: ACRIN 6666. *Radiology*, 254, 79–87. doi:10.1148/radiol.2541090953 [PubMed: 20032143]
- Berg WA, Zhang Z, Lehrer D, Jong RA, Pisano ED, & Barr RG ACRIN 6666 Investigators. (2012). Detection of breast cancer with addition of annual screening ultrasound or a single screening MRI to mammography in women with elevated breast cancer risk. *JAMA*, 307, 1394–1404. doi:10.1001/jama.2012.388 [PubMed: 22474203]
- Berry DA, Iversen ES Jr, Gudbjartsson DF, Hiller EH, Garber JE, Peshkin BN, ... Parmigiani G (2002). BRCAPRO validation, sensitivity of genetic testing of BRCA1/BRCA2, and prevalence of other breast cancer susceptibility genes. *Journal of Clinical Oncology*, 20, 2701–2712. doi:10.1200/JCO.2002.05.121 [PubMed: 12039933]
- Beyers TB, Ward JH, Arun BK, Colditz GA, Cowan KH, Daly MB, ... Kumar R (2015). Breast cancer risk reduction, Version 2. *Journal of the National Comprehensive Cancer Network*, 13, 880–915. [PubMed: 26150582]
- Brinton JT, Barke LD, Freivogel ME, Jackson S, O'Donnell CI, & Glueck DH (2012). Breast cancer risk assessment in 64,659 women at a single high-volume mammography clinic. *Academic Radiology*, 19, 95–99. doi:10.1016/j.acra.2011.09.003 [PubMed: 22054804]
- Claus EB (2000). Risk models in genetic epidemiology. *Statistical Methods in Medical Research*, 9, 589–601. doi:10.1191/096228000675337994 [PubMed: 11308072]
- D'Orsi CJ, Bassett LW, Berg WA, et al. (2003) BI-RADS: Mammography In D'Orsi CJ, Mendelson EB, Ikeda DM, et al., (Eds.), *Breast imaging reporting and data system: ACR BI-RADS – Breast imaging atlas* (4th ed.). Reston, VA: American College of Radiology.
- Decarli A, Calza S, Masala G, Specchia C, Palli D, & Gail MH (2006). Gail model for prediction of absolute risk of invasive breast cancer: Independent evaluation in the Florence–European prospective investigation into cancer and nutrition cohort. *Journal of the National Cancer Institute*, 98, 1686–1693. doi:10.1093/jnci/djj463 [PubMed: 17148770]
- Ehsani S, Strigel RM, Pettke E, Wilke L, Tevaarwerk AJ, DeMartini WB, & Wisinski KB (2015). Screening magnetic resonance imaging recommendations and outcomes in patients at high risk for breast cancer. *The Breast Journal*, 21, 246–253. doi:10.1111/tbj.12396 [PubMed: 25789917]
- Gail MH, Brinton LA, Byar DP, Corle DK, Green SB, Schairer C, & Mulvihill JJ (1989). Projecting individualized probabilities of developing breast cancer for white females who are being examined annually. *Journal of the National Cancer Institute*, 81, 1879–1886. doi:10.1093/jnci/81.24.1879 [PubMed: 2593165]
- Hollingsworth AB, & Stough RG (2014). An alternative approach to selecting patients for high-risk screening with breast MRI. *The Breast Journal*, 20, 192–197. doi:10.1111/tbj.12242 [PubMed: 24387050]
- Jepson R, Hewison J, Thompson A, & Weller D (2005). How should we measure informed choice? The case of cancer screening. *Journal of Medical Ethics*, 31, 192–196. doi:10.1136/jme.2003.005793 [PubMed: 15800356]

- Miller JW, Sabatino SA, Thompson TD, Breen N, White MC, Ryerson AB, ... Ballard-Barbash R (2013). Breast MRI use uncommon among U.S. women. *Cancer Epidemiology, Biomarkers & Prevention*, 22, 159–166. doi:10.1158/1055-9965.EPI-12-0967
- Narod SA, Iqbal J, Giannakeas V, Sopik V, & Sun P (2015). Breast cancer mortality after a diagnosis of ductal carcinoma in situ. *JAMA Oncology*, 1, 888–896. doi:10.1001/jamaoncol.2015.2510 [PubMed: 26291673]
- Nelson HD, Tyne K, Naik A, Bougatsos C, Chan B, Nygren P, & Humphrey L (2009). Screening for breast cancer: Systematic evidence review update for the U.S. preventive services task force Evidence Review Update No. 74. AHRQ Publication No. 10-05142-EF-1. Rockville, MD: Agency for Healthcare Research and Quality Retrieved from <http://www.ncbi.nlm.nih.gov/books/NBK36392/>
- Raikhlin A, Curpen B, Warner E, Betel C, Wright B, & Jong R (2015). Breast MRI as an adjunct to mammography for breast cancer screening in high-risk patients: Retrospective review. *AJR. American Journal of Roentgenology*, 204, 889–897. doi:10.2214/AJR.13.12264 [PubMed: 25794083]
- Saadatmand S, Obdeijn I-M, Rutgers EJ, Oosterwijk JC, Tollenaar RA, Woldringh GH, ... Tilanus-Linthorst MM (2015). Survival benefit in women with BRCA1 mutation or familial risk in the MRI screening study (MRISC). *International Journal of Cancer*, 137, 1729–1738. doi:10.1002/ijc.29534 [PubMed: 25820931]
- Saadatmand S, Tilanus-Linthorst MMA, Rutgers EJT, Hoogerbrugge N, Oosterwijk JC, Tollenaar RAEM, ... de Koning HJ (2013). Cost-effectiveness of screening women with familial risk for breast cancer with magnetic resonance imaging. *Journal of the National Cancer Institute*, 105, 1314–1321. doi:10.1093/jnci/djt203 [PubMed: 23940285]
- SAS Institute Inc. (2011). *SAS/STAT® 9.3 user's guide*. Cary, NC: SAS Institute Inc.
- Saslow D, Boetes C, Burke W, Harms S, Leach MO, Lehman CD, ... Russell CA (2007). American cancer society guidelines for breast screening with MRI as an adjunct to mammography. *CA: A Cancer Journal for Clinicians*, 57, 75–89. [PubMed: 17392385]
- Tyrer J, Duffy SW, & Cuzick J (2004). A breast cancer prediction model incorporating familial and personal risk factors. *Statistics in Medicine*, 23, 1111–1130. doi:10.1002/sim.1668 [PubMed: 15057881]
- Warner E, Hill K, Causer P, Plewes D, Jong R, Yaffe M, ... Narod SA (2011). Prospective study of breast cancer incidence in women with a BRCA1 or BRCA2 mutation under surveillance with and without magnetic resonance imaging. *Journal of Clinical Oncology*, 29, 1664–1669. doi:10.1200/JCO.2009.27.0835 [PubMed: 21444874]
- Wernli KJ, DeMartini WB, Ichikawa L, Lehman CD, Onega T, Kerlikowske K, ... Yankaskas BC (2014). Patterns of breast magnetic resonance imaging use in community practice. *JAMA Internal Medicine*, 174, 125–132. doi:10.1001/jamainternmed.2013.11963 [PubMed: 24247555]

Figure 1.
Risk assessment and ACS recommendation communication flow.

Table 1.

Comparison of age and Gail score by study window and screening frequency categories.

Patient characteristics	Groups				Group comparisons (<i>p</i> value)			
	OA N = 153	OB N = 306	RA N = 102	RB N = 102	OA vs. RA	OA vs. OB	OB vs. RB	
Age (years)	52.3 ± 8.7	51.3 ± 8.5	52.9 ± 7.8	53.9 ± 7.8	0.5730	0.2271	0.0035	
Gail score	22.8 [20.9–27.4]	22.05 [20.3–25.1]	23.8 [21–27.5]	22.7 [20.7–26.3]	0.7540	0.0026	0.1334	
MRI recommendation in the previous year's imaging reports								
Yes	66 (44.6)	78 (25.7)	53 (53.0)	102 (100.0)	0.1985	<0.001	<0.001	
No	82 (55.4)	225 (74.3)	47 (47.0)	0 (0.0)				
Missing	5	3	2	0				

Note: Statistics are presented as mean ± SD, median [IQR], or frequency (%). OA = one-time screeners Window A; OB = one-time screeners Window B; RA = repeat screener Window A; RB = repeat screener Window A.

Table 2.

Completion rates of recommended screening breast MRI by study window and screening frequency categories.

	Window A	Window B	<i>p</i> value
One-time screeners	9.8% (5.6%—15.7%) <i>N</i> = 153	14.4% (10.7%—18.9%) <i>N</i> = 306	<i>p</i> = 0.0467
Repeat screeners	0% (0.0%—3.6%) <i>N</i> = 102 <i>p</i> = 0.0005	6.9% (2.8%—13.6%) <i>N</i> = 102 <i>p</i> = 0.0563	<i>p</i> = 0.0156 ^{<i>a</i>}

Note: Frequency (95% confidence interval).

^{*a*}McNemar's test comparing repeat screeners otherwise Fisher's exact.