American Journal of
Preventive Medicine

RESEARCH BRIEF

Mammography and Decision Aid Use for Breast Cancer Screening in Older Women

Rachel L. Ross, MPH, Karl Rubio, MIA, Hector P. Rodriguez, PhD, MPH

Introduction: Decision aids for breast cancer screening are increasingly being used by physicians, but the association between physician practice decision-aid use and mammography rates remains uncertain. Using national data, this study examines the association between practice-level decision-aid use and mammography use among older women.

Methods: Physician practice responses to the 2017/2018 National Survey of Healthcare Organizations and Systems (n=1,236) were linked to 2016 and 2017 Medicare fee-for-service beneficiary data from eligible beneficiaries (n=439,684) aged 65−74 years. In 2021, multivariable generalized linear models estimated the association of practice decision-aid use for breast cancer screening and advanced health information technology functions with mammography use, controlling for practice and beneficiary characteristics.

Results: Overall, 60.1% of eligible beneficiaries had a screening mammogram, and 37.3% of physician practices routinely used decision aids for breast cancer screening. In adjusted analyses, advanced health information technology functions (OR=1.19, p=0.04) were associated with mammography use, but practice use of decision aids was not (OR=0.95, p=0.21). Beneficiary clinical and socioeconomic characteristics, including race, comorbidities, Medicare and Medicaid eligibility, and median household income were more strongly associated with mammography use than practice-level decision-aid use or advanced health information technology functions.

Conclusions: Health information technology–enabled automation of mammography reminders and other advanced health information technology functions may support mammography, whereas breast cancer decision aids may reduce patients' propensities to be screened through the alignment of their preferences and screening decision. More resources may be needed for decision aids to be routinely implemented to improve solicitation of patient preferences and targeting of mammography services.

INTRODUCTION

Breast cancer is the most common cancer among women in the U.S., constituting the second leading cause of cancer death among women overall.[1] U.S. Preventive Services Task Force guidelines recommend that eligible women receive biennial mammograms until age 74 years,[2] although evidence is mixed regarding the importance of screening beyond age 70 years.[3-5] Although mammography can enable early detection of cancer, false-positive results remain a risk. Overdiagnosis occurs when malignancies are detected that would not have resulted in clinical significance; it is estimated that up to 25% of breast cancer cases may be overdiagnosed.[6-8] Decisions about whether to undergo mammography should depend on patients' risks and preferences and include a structured discussion about the risks and benefits of screening.[6,9]

Decision aids (DAs) can help clinicians to structure conversations about screening decisions, costs, and

From the Division of Health Policy and Management, School of Public Health, University of California, Berkeley, Berkeley, California

Address correspondence to: Hector P. Rodriguez, PhD, MPH, Division of Health Policy and Management, School of Public Health, University of California, Berkeley, 2121 Berkeley Way #5427, Berkeley CA 94704. E-mail address: hrod@berkeley.edu.

0749-3797/$36.00
https://doi.org/10.1016/j.amepre.2022.04.014

benefits of various choices[10] and patients' health goals.[11] Breast cancer screening DAs can increase patient awareness of the risks associated with overdiagnosis.[12−15] To date, there is mixed evidence about the association of DAs with mammography use. For example, 1 systematic review found that DAs have minimal impact on screening decisions,[16] whereas another found that DAs reduce screening intentions.[17] Although DA use is low overall,[18] practices that integrate them into clinic workflows use DAs more consistently.[19] Practices with more advanced health information technology (HIT) may be more likely to use HIT-enabled DAs and patient reminders, which can impact mammography screening rates.

No national evidence exists about whether physician practice adoption of DAs for breast cancer screening or HIT functions are associated with mammography use among older adult women. This analysis fills a critical gap in evidence by analyzing a national sample of physician practices and claims data from eligible, attributed Medicare fee-for-service (FFS) beneficiaries.

METHODS

Physician practice responses to the 2017/2018 National Survey of Healthcare Organizations and Systems (NSHOS) were linked to 2017 Medicare FFS beneficiary and claims data using National Provider Identifiers. NSHOS used a stratified-cluster sampling design to select eligible physician practices and yielded a response rate of 47%.[20]

The analytic sample includes female beneficiaries aged 65−74 years with Part B eligibility and no HMO enrollment in 2017 or 2016. Practices with <100 attributed beneficiaries (n=493) were excluded to ensure the reliable estimation of practice effects on mammography use.[21] Appendix Table 1 (available online) provides analytic sample exclusions. The final sample includes 439,684 Medicare FFS beneficiaries attributed to 1 of 1,236 NSHOS physician practice responses (average beneficiaries per practice=285, SD=344).

The dependent variable is receipt of screening mammography as indicated in Medicare FFS claims data from the cohort of eligible beneficiaries in 2017, with a 2-year look-back period of 2016−2017 to assess mammography use. The independent variables are (1) a dichotomous measure of physician practice use of DAs for breast cancer screening and (2) a composite measure of advanced HIT functions (range: 0−100). Practice-level control variables include practice size, ownership, specialist-to-primary care physician ratio, and advanced practice clinician count. Patient-level control variables include patient age, race/ethnicity, Hierarchical Condition Category risk scores (i.e., comorbidities), dual eligibility for Medicare and Medicaid, high-poverty ZIP code, and median household income (Appendix Table 2, available online, provides measure definitions).

Multivariable generalized linear models were estimated to examine the association of practices' DA use and HIT functions with patient-level receipt of mammography. Complete case analyses were conducted. Model 1 examined the association of practice- and patient-level variables with mammography use. Model 2 extends Model 1 and includes an interaction term between HIT and DA use. Predicted probabilities of mammography use were calculated to illustrate how use varied by DA use and HIT in adjusted analyses. All statistical analyses were conducted using Stata statistical software.[22] The study was approved by the IRB at the University of California, Berkeley and Dartmouth College.

RESULTS

Overall, 60.1% of eligible beneficiaries had a mammogram, 37.3% of practices routinely used DAs for breast cancer screening, and advanced HIT functions averaged 0.60 (SD=0.47). In unadjusted analyses, beneficiaries who did not have a mammogram were more likely to be attributed to practices that routinely used DAs than beneficiaries who had a mammogram (37.9% vs 37.0%, p<0.001) (Table 1).

In adjusted analyses, routine DA use was not significantly associated with patient-level mammography use (OR=0.95, p=0.21) (Table 2) (Model 1). Beneficiaries attributed to practices with higher specialist-to-primary care physician ratios (OR=0.61, p<0.01) were less likely to have a mammogram, whereas beneficiaries of practices owned by a hospital or health system (OR=1.18, p<0.01) and more advanced HIT functions (OR=1.19, p<0.05) were more likely to have a mammogram.

Older age (OR=0.95, p<0.05), Asian race (OR=0.78, p<0.001), more comorbidities (OR=0.81, p<0.001), dual Medicare and Medicaid eligibility (OR=0.60, p<0.001), and high-poverty ZIP code of residence (OR=0.91, p<0.001) were associated with lower odds of mammography use (Table 2) (Model 1). Black race (OR=1.13, p<0.01) and greater median household income (OR=1.06, p<0.001) were associated with higher odds of mammography use. There was no interaction effect between DA use and HIT (Table 2) (Model 2). Predicted probabilities based on Model 2 are presented in Figure 1. Results were largely consistent for models (1) that included all practices with attributed beneficiaries, irrespective of volume (Appendix Tables 3 and 4, available online), and (2) when DA use for any preference-sensitive condition was considered (Appendix Table 5, available online).

DISCUSSION

DAs are encouraged by payers because of their potential to reduce costs and improve quality.[23] The authors hypothesized that advanced HIT would enable DA use and patient reminders for mammography, which could impact mammography rates. Although practice DA use was associated with patient-level mammography use in unadjusted analyses, the DA effect attenuates once advanced HIT and other practice characteristics

Table 1. Patient and Practice Characteristics, by Practice-Level Mammography Use

Characteristics	Overall Mean	Beneficiaries without screening mammography in the past 2 years Mean	Beneficiaries with screening mammography in the past 2 years Mean	Difference *p*-value
Patient *n* (% of analytic sample)	439,684 (100)	171,984 (39.1)	267,700 (60.9)	–
Main predictors				
Practice use of breast cancer screening decision aids (%)	37.3	37.9	37.0	***
Practice advanced HIT functions, mean (SD)	0.600 (0.470)	0.590 (0.480)	0.600 (0.470)	***
Practice characteristics				
Practice size				
3–7 physicians (%)	43.2	43.4	43.1	–
8–12 physicians (%)	19.1	18.4	19.6	***
13–19 physicians (%)	8.20	8.50	8.10	***
≥20 physicians (%)	29.4	29.8	29.2	*
Specialty mixture				
No specialists (%)	26.9	26.5	27.2	**
Low (%)	24.3	26.0	23.2	***
Moderate (%)	23.7	22.9	24.3	***
High (%)	25.0	24.6	25.3	***
Total advanced practice clinicians, mean (SD)	5.40 (18.1)	5.10 (16.0)	5.60 (19.4)	***
Practice ownership				
Independently owned (%)	39.3	40.9	38.2	***
Medical group owned (%)	13.4	12.8	13.7	***
System owned (%)	47.3	46.3	48.0	***
Patient characteristics				
Age	69.2	68.5	69.7	***
Race/ethnicity				
White (%)	86.3	85.2	87.0	***
Black (%)	7.10	7.70	6.60	***
Asian (%)	1.80	2.20	1.60	***
Latinx (%)	0.700	0.900	0.600	***
Other (%)	4.00	4.00	4.10	–
HCC score, mean (SD)	0.710 (0.760)	0.790 (0.440)	0.650 (0.00)	***
Dual Medicare/Medicaid eligibility (%)	2.90	4.10	2.10	***
Frail elder (%)	2.80	3.30	2.50	***
Mental illness (%)	21.0	22.6	20.0	***
High-poverty ZIP code (%)	14.8	16.1	13.9	***
Annual median household income, mean (SD)	$61,921 ($42,676)	$60,790 ($42,505)	$62,267 (42,726)	***

Note: Boldface indicates statistical significance (*$p<0.05$. **$p<0.01$. ***$p<0.001$).
HCC, hierarchical condition category; HTT, health information technology.

are considered. The results suggest that HIT and DAs may have countervailing relationships with mammography use among older adult women. HIT-enabled automation of mammography reminders and other advanced HIT functions may support mammography,[18] whereas breast cancer DAs may reduce patients' propensities to be screened through the alignment of their preferences and screening decision. This may be why we found relatively small associations between DA use and advanced HIT functions with mammography use in adjusted analyses that consider both variables simultaneously.

Specialty mixture of physician practices was associated with lower mammography rates, suggesting that having proportionally more specialist physicians may not specifically incentivize breast cancer screening activity. Alternatively, hospital or health system ownership was associated with greater mammography rates,

Table 2. Association of Practice Adoption of DAs and Advanced HTT Capabilities With Mammography

Variables	Model 1: Full model with patient and practice characteristics	Model 2: Full model with DA* HIT interaction
Main predictors (practice variables)		
Practice use of breast cancer screening DAs	0.95 (0.87, 1.03)	0.94 (0.85, 1.03)
Practice advanced HIT functions	**1.19 (1.01, 1.40)***	1.17 (0.970, 1.40)
Practice use of DAs X practice HIT functions	–	1.05 (0.890, 1.24)
Practice characteristics		
Practice size		
3–7 Physicians (ref)	–	–
8–12 physicians	1.10 (0.95, 1.29)	1.10 (0.95, 1.29)
13–19 physicians	0.96 (0.83, 1.10)	0.96 (0.84, 1.10)
≥20 physicians	1.06 (0.92, 1.22)	1.06 (0.92, 1.22)
Specialist ratio	**0.61 (0.43, 0.85)****	**0.61 (0.43, 0.86)****
Total advanced practice clinicians	0.95 (0.82, 1.11)	0.95 (0.82, 1.11)
Practice ownership		
Independently owned (ref)	–	–
Medical group owned	1.16 (1.00, 1.34)	1.16 (0.99, 1.34)
System owned	**1.18 (1.06, 1.31)****	**1.18 (1.06, 1.31)****
Patient characteristics		
Age	**0.95 (0.92, 0.99)***	**0.95 (0.92, 0.99)***
Race/ethnicity		
White (ref)	–	–
Black	**1.13 (1.04, 1.23)****	**1.13 (1.04, 1.23)****
Asian	**0.78 (0.71, 0.86)*****	**0.78 (0.71, 0.86)*****
Latinx	0.89 (0.76, 1.05)	0.89 (0.76, 1.05)
Others	0.99 (0.92, 1.06)	0.99 (0.92, 1.06)
HCCs score	**0.81 (0.80, 0.82)*****	**0.81 (0.80, 0.82)*****
Dual Medicare/Medicaid	**0.60 (0.56, 0.65)*****	**0.60 (0.56, 0.65)*****
High-poverty ZIP code	**0.91 (0.87, 0.95)*****	**0.91 (0.87, 0.95)*****
Annual median household income	**1.06 (1.04, 1.08)*****	**1.06 (1.04, 1.08)*****
Constant	**2.31 (2.02, 2.63)*****	**2.33 (2.02, 2.69)*****
Total beneficiaries	439,684	439,684
Total physician practices	1,236	1,236

Note: Boldface indicates statistical significance (*p<0.05, **p<0.01, ***p<0.001).
The outcome is patient-level screening mammography use. ORs and 95% CIs are reported.
DA, decision aid; HCC, hierarchical condition category; HTT, health information technology.

suggesting that the availability of organizational resources may enable greater screening capacity.

Limitations

This study has some limitations. First, NSHOS assessed breast cancer screening DA use with a single question; DA design, implementation strategies, and patient populations targeted were not assessed. Second, NSHOS does not include small (<3 primary care physicians) or federally owned practices, so the results may not generalize to them. Third, the 47% NSHOS survey response rate may bias results; however, respondent and nonrespondent practices do not substantially differ (Appendix Table 6, available online). Fourth, racial/ethnic diversity is low because Medicare FFS data were analyzed; inclusion of Medicare Advantage data may improve generalizability. Finally, although mammography was assessed over 2 years, the authors could not account for delays/refusals at the patient-level. Future work should include a more robust assessment of patient-level factors associated with DA use and mammography, with an emphasis on understanding how DA use shifts patients differentially toward and away from mammography use to impact overall patterns of use.[24]

CONCLUSIONS

U.S. Preventive Services Task Force guidelines recommend breast cancer screening through the age of 74 years, but concerns about overdiagnosis and harm

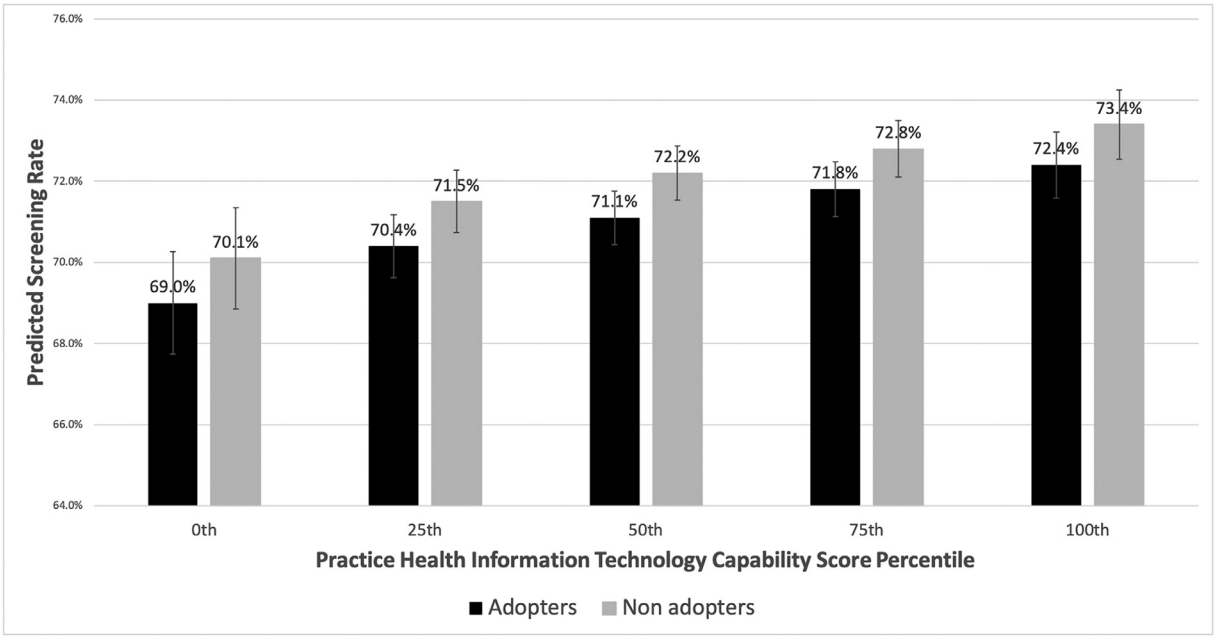

Figure 1. Mammography use, by practice adoption of breast cancer decision aids and advanced HIT capabilities.
Note: Adopters denote that practice use decision aids for breast cancer screening (use for all or most eligible patients), Nonadopters denote that practice does not use decision aids for breast cancer screening (use for none or some eligible patients). The advanced HIT scores (range: 0–100) associated with each percentile cutpoint are as follows: 0th percentile cutpoint=0, 25th percentile cutpoint=38.1, 50th percentile cut off=52.4, 75th percentile cut off=66.7, and 100th percentile cut off=100.
HTT, health information technology.

underscore the importance of patient–provider communication regarding risk–benefit trade-offs.[25–27] Despite increasing awareness of breast cancer screening DAs, the present results indicate that they likely have not been implemented consistently enough to have an impact on mammography use among older women. More resources may be needed for physician practices to routinely implement DAs and improve elicitation of patients' preferences and targeting of mammography services.

ACKNOWLEDGMENTS

The statements, findings, conclusions, views, and opinions contained and expressed in this article are based in part on data obtained under license from IQVIA information services: OneKey subscription information services 2010–2017, IQVIA incorporated all rights reserved. The statements, findings, conclusions, views, and opinions contained and expressed in this article are not necessarily those of IQVIA Incorporated or any of its affiliated or subsidiary entities. We are grateful to Deanna Chyn and Devang Agravat of The Dartmouth Institute for Health Policy & Clinical Practice for their assistance with data management and variable construction.

This study was supported by the Agency for Healthcare Research and Quality's Comparative Health System Performance Initiative under Grant Number 1U19HS024075, which studies how healthcare delivery systems promote evidence-based practices and patient-centered outcomes research in delivering care. RLR received support from the Agency for Healthcare Research and Quality (T32HS022241). American Medical Association is the source for these data; statistics, tables, and tabulations were prepared using AMA Masterfile data.

No financial disclosures were reported by the authors of this paper.

CREDIT AUTHOR STATEMENT

Rachel L. Ross: Conceptualization, Methodology, Writing - original draft, Writing- review and editing. Karl Rubio: Formal analysis, Methodology, Software, Visualization, Writing - review and editing. Hector P. Rodriguez: Conceptualization, Funding acquisition, Methodology, Project administration, Resources, Supervision, Writing - review and editing.

SUPPLEMENTAL MATERIAL

Supplemental materials associated with this article can be found in the online version at https://doi.org/10.1016/j.amepre.2022.04.014.

REFERENCES

1. Basic information about breast cancer. Centers for Disease Control and Prevention. https://www.cdc.gov/cancer/breast/basic_info/index.htm. Updated September 20, 2021. Accessed November 26, 2021.
2. U.S. Preventive Services Task force. Recommendation: breast cancer: screening. Rockville, MD: U.S. Preventive Services Task force, 2022

https://www.uspreventiveservicestaskforce.org/uspstf/recommendation/breast-cancer-screening#fullrecommendationstart. Published January 11, 2016. Accessed February 9, 2022.

3. Nelson HD, Tyne K, Naik A, et al. Screening for breast cancer: an update for the U.S. Preventive Services Task Force. *Ann Intern Med.* 2009;151(10):727–737. https://doi.org/10.7326/0003-4819-151-10-200911170-00009.
4. Fedewa SA, de Moor JS, Ward EM, et al. Mammography use and physician recommendation after the 2009 U.S. Preventive Services Task Force breast cancer screening recommendations. *Am J Prev Med.* 2016;50(5):e123–e131. https://doi.org/10.1016/j.amepre.2015.10.010.
5. McCarthy EP, Burns RB, Freund KM, et al. Mammography use, breast cancer stage at diagnosis, and survival among older women. *J Am Geriatr Soc.* 2000;48(10):1226–1233. https://doi.org/10.1111/j.1532-5415.2000.tb02595.x.
6. Welch HG, Black WC. Overdiagnosis in cancer. *J Natl Cancer Inst.* 2010;102(9):605–613. https://doi.org/10.1093/jnci/djq099.
7. de Gelder R, Heijnsdijk EA, van Ravesteyn NT, Fracheboud J, Draisma G, de Koning HJ. Interpreting overdiagnosis estimates in population-based mammography screening. *Epidemiol Rev.* 2011;33(1):111–121. https://doi.org/10.1093/epirev/mxr009.
8. Monticciolo DL, Helvie MA, Hendrick RE. Current issues in the overdiagnosis and overtreatment of breast cancer. *AJR Am J Roentgenol.* 2018;210(2):285–291. https://doi.org/10.2214/AJR.17.18629.
9. Hersch J, Jansen J, Barratt A, et al. Women's views on overdiagnosis in breast cancer screening: a qualitative study. *BMJ.* 2013;346:f158. https://doi.org/10.1136/bmj.f158.
10. Cohen EO, Weaver OO, Tso HH, Gerlach KE, Leung JWT. Breast cancer screening via digital mammography, synthetic mammography, and tomosynthesis. *Am J Prev Med.* 2020;58(3):470–472. https://doi.org/10.1016/j.amepre.2019.09.016.
11. O'Connor AM, Rostom A, Fiset V, et al. Decision aids for patients facing health treatment or screening decisions: systematic review. *BMJ.* 1999;319(7212):731–734. https://doi.org/10.1136/bmj.319.7212.731.
12. Martínez-Alonso M, Carles-Lavila M, Pérez-Lacasta MJ, et al. Assessment of the effects of decision aids about breast cancer screening: a systematic review and meta-analysis. *BMJ Open.* 2017;7(10):e016894. https://doi.org/10.1136/bmjopen-2017-016894.
13. Yu L, Li P, Yang S, et al. Web-based decision aids to support breast cancer screening decisions: systematic review and meta-analysis. *J Comp Eff Res.* 2020;9(14):985–1002. https://doi.org/10.2217/cer-2020-0052.
14. Hersch J, Barratt A, Jansen J, et al. Use of a decision aid including information on overdetection to support informed choice about breast cancer screening: a randomised controlled trial [published correction appears in *Lancet.* 2015;385(9978):1622]. *Lancet.* 2015;385(9978):1642–1652. https://doi.org/10.1016/S0140-6736(15)60123-4.
15. Schonberg MA, Davis RB, Karamourtopoulos MC, et al. A pre-test-post-test trial of a breast cancer risk report for women in their 40s. *Am J Prev Med.* 2020;59(3):343–354. https://doi.org/10.1016/j.amepre.2020.04.014.
16. Esmaeili M, Ayyoubzadeh SM, Javanmard Z, R Niakan Kalhori S. A systematic review of decision aids for mammography screening: focus on outcomes and characteristics. *Int J Med Inform.* 2021;149:104406. https://doi.org/10.1016/j.ijmedinf.2021.104406.
17. Ivlev I, Hickman EN, McDonagh MS, Eden KB. Use of patient decision aids increased younger women's reluctance to begin screening mammography: a systematic review and meta-analysis. *J Gen Intern Med.* 2017;32(7):803–812. https://doi.org/10.1007/s11606-017-4027-9.
18. Légaré F, Witteman HO. Shared decision making: examining key elements and barriers to adoption into routine clinical practice. *Health Aff (Millwood).* 2013;32(2):276–284. https://doi.org/10.1377/hlthaff.2012.1078.
19. Stacey D, Légaré F, Lewis K, et al. Decision aids for people facing health treatment or screening decisions. *Cochrane Database Syst Rev.* 2017(4):CD001431. https://doi.org/10.1002/14651858.CD001431.pub5.
20. Fisher ES, Shortell SM, O'Malley AJ, et al. Financial integration's impact on care delivery and payment reforms: a survey of hospitals and physician practices. *Health Aff (Millwood).* 2020;39(8):1302–1311. https://doi.org/10.1377/hlthaff.2019.01813.
21. Sequist TD, Schneider EC, Li A, Rogers WH, Safran DG. Reliability of medical group and physician performance measurement in the primary care setting. *Med Care.* 2011;49(2):126–131. https://doi.org/10.1097/MLR.0b013e3181d5690f.
22. StataCorp. *Stata Statistical Software*: Release 17. College Station, TX: StataCorp LLC, 2021.
23. Hansen SF. *The role of decision Aids in the Affordable Care Act*. Stanford, CA: Stanford Journal of Public Health, 2013 https://www.stanford.edu/group/sjph/cgi-bin/sjphsite/the-role-of-decision-aids-in-the-affordable-care-act/ Published October 20, 2013. Accessed February 9, 2022.
24. Hurley VB, Wang Y, Rodriguez HP, Shortell SM, Kearing S, Savitz LA. Decision aid implementation and patients' preferences for hip and knee osteoarthritis treatment: insights from the high value healthcare collaborative. *Patient Prefer Adherence.* 2020;14:23–32. https://doi.org/10.2147/PPA.S227207.
25. Pashayan N, Morris S, Gilbert FJ, Pharoah PDP. Cost-effectiveness and benefit-to-harm ratio of risk-stratified screening for breast cancer: a life-table model [published correction appears in *JAMA Oncol.* 2022;8(3):484]. *JAMA Oncol.* 2018;4(11):1504–1510. https://doi.org/10.1001/jamaoncol.2018.1901.
26. Løberg M, Lousdal ML, Bretthauer M, Kalager M. Benefits and harms of mammography screening. *Breast Cancer Res.* 2015;17(1):63. https://doi.org/10.1186/s13058-015-0525-z.
27. Barratt AL, Les Irwig M, Glasziou PP, Salkeld GP, Houssami N. Benefits, harms and costs of screening mammography in women 70 years and over: a systematic review. *Med J Aust.* 2002;176(6):266–271. https://doi.org/10.5694/j.1326-5377.2002.tb04405.x.