Effectiveness of Interventions Designed to Increase Mammography Use: A Meta-Analysis of Provider-targeted Strategies[1]

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Abstract

The objective of this study was to determine the effectiveness of interventions targeted at providers to enhance the use of mammography. We performed a meta-analysis and included United States studies that used a randomized or nonrandomized concurrent control design, had defined outcomes, and presented data that could be abstracted for reanalysis. Interventions were classified as behavioral, cognitive, or sociological and further categorized by the type of control group (active *versus* usual care). Data were combined using DerSimonian and Laird random effects models to yield summary effect sizes. Thirty-five studies met the inclusion criteria. All types of interventions targeted at providers were effective in increasing mammography rates. Behavioral interventions increased screening by 13.2% [95% confidence interval (CI), 7.8–18.4] as compared with usual care and by 6.8% (95% CI, 4.8–8.7) as compared with active controls. Cognitive intervention strategies improved mammography rates by 18.6% (95% CI, 12.8–24.4). Sociological interventions also had a similar magnitude of effect on screening rates (13.1% increase; 95% CI, 6.8–19.3). Interventions targeting both patients and providers were not significantly better at increasing screening than those targeting providers alone, and multiple approaches (*e.g.*, behavioral and cognitive) were generally not more effective than a single approach. All interventions targeted at physicians were effective in increasing screening rates. Decisions to use a particular approach will depend on resources, expertise, feasibility, and cost effectiveness.

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Introduction

Despite evidence that regular mammography screening can reduce breast cancer mortality (1–4), many women fail to receive mammography or adhere to recommended guidelines for routine ongoing screening. A proportion of this underuse is due to an apparent paradox: whereas physician recommendation is one of the strongest predictors of mammography use (5–6), the most frequent reason cited by women for failure to have mammography is that a physician did not recommend one (5–6).

To overcome this apparent paradox, numerous interventions have been developed to enhance physician ordering or recommendation of screening mammography. However, because of the large number of different interventions, numerous mechanisms of intervention action, and variability in study design, it is difficult to develop a cohesive recommendation to improving physician screening behaviors, particularly in high-risk patient populations. An earlier meta-analysis of physician-targeted interventions to improve the use of mammography screening and clinical breast examinations indicated that most interventions were effective in increasing screening, but the magnitude of this effect varied by the type of intervention (7). Since preparation of that report, more than 50 additional studies to increase mammography utilization have been published (8–58).

In this study, we performed an updated critical review of well-designed provider-targeted interventions designed to increase the use of mammography. We estimate overall effect sizes for specific types of interventions to determine the most effective strategies to increase mammography utilization.

Materials and Methods

Study Selection. We used the OVID search mechanism with MEDLINE for the years 1980–1998 to identify published English language articles on interventions to increase mammography utilization. The search strategy was as follows: we used the terms "mammography" or "breast neoplasms/prevention and control" to identify the subset of studies focused on mammography screening. We then developed a series of terms to identify settings in which interventions could take place (*e.g.*, "primary health care," "gynecology," and "family physicians") and the terms "health education," "health behavior," "patient compliance," "patient acceptance of health care," "attitude to health," or "health promotion." The combination of these searches yielded 600 studies. Study abstracts were reviewed for evidence of prospective follow-up with either randomized assignment to an intervention or control group or a nonrandomly selected concurrent control group. Because interventions were designed to increase the recommendation of mammography, we include studies that used either outcomes of ordering screening or completion rates of screening. Studies that relied on physician estimates of mammography recommendations were excluded (28, 59) because such self-reports are often inaccurate. Pre/post

designs without controls and uncontrolled trials were excluded. Published abstracts were also excluded because they were judged to have too brief a description of methods for assessment.

Twenty-one studies met the inclusion criteria. Reference lists of the selected studies were also searched to identify other eligible studies, and a hand search of Journal of General Internal Medicine, Medical Care, Preventive Medicine, Annals of Internal Medicine, Archives of Internal Medicine, and Cancer Epidemiology, Biomarkers and Prevention was conducted for June-August 1998. Fourteen additional studies were thus identified, yielding a total of 35 studies.

Data Abstraction. We classified interventions as cognitive, behavioral, or sociological (60). Cognitive strategies provide new information and education, increase existing knowledge, and clarify misperceptions. Interventions that provided education or audit of practice with feedback were classified as cognitive. Behavioral interventions alter cues or stimuli associated with screening behavior and included reminders or administrative office systems. Sociological interventions use social norms or peers to increase screening adherence. We classified interventions that altered the structure of care delivery, in many cases through the use of nurse practitioners, as sociological. We also classified interventions with multiple types of strategies (*e.g.*, reminders, education) as behavioral and cognitive. Where a sufficient number of interventions were available, interventions were further classified by the type of control group used, active control and usual care control. Active control groups included a lower level of an intervention, such as routine reminders or flow sheets in patient charts. We defined usual care controls as situations in which no intervention associated with mammography utilization was performed. In settings where usual care included routine reminders or flow sheets in patient charts, these interventions were classified as having an active control group.

Interventions were also classified by the individuals or group they targeted: providers; providers and patients; or, in cases where individual providers or patients were not explicitly identified, communities. The interventions we classified as targeted to communities attempted to educate or remind large groups of individuals through the media, generalized educational efforts, newsletters, flyers, and posters rather than personalized contact.

Data were abstracted from studies using a standardized abstraction format to describe the type of intervention, characteristics of mammography outcome determination (patient self-report, medical charts, electronic records, or medical claims), the patient population, and intervention effectiveness. Studies with multiple interventions had these data abstracted where possible. Additionally, for studies with multiple assessment points over time, the first assessment was used in the combined analysis.

Data Analysis. The effect size and 95% CI[3] were calculated for each intervention included in the study. For randomized studies, intervention effectiveness was calculated as the difference in mammography utilization between the intervention and control group at the end of the study. For nonrandomized concurrently controlled trials, the effect size was calculated as the difference between the rates postintervention and preintervention for the intervention group and the control group. The formulas we used to calculate variance for randomized and nonrandomized concurrently controlled trials are listed in the Appendix.

Tests of homogeneity, the DerSimonian and Laird Q-statistic (61), were performed for interventions grouped by mechanism of action (behavioral, cognitive, or sociological) and the type of control group. This statistic, which compares the summary effect measure and within-study effect, was compared against a χ^2 distribution with a null hypothesis of homogeneity. Meta-Analyst software (62) was used to calculate DerSimonian and Laird random effects summary statistics and 95% CIs (61). These are reported separately for different types of interventions. All analyses were performed under the null hypothesis of no difference in mammography use between intervention and control.

To test the influence of a single intervention on summarized results, we performed sensitivity analysis by sequentially dropping each intervention and recalculating the summary statistics.

Results

Among the 35 studies in the final study sample, some included multiple interventions, and several targeted patients and providers. Overall, there were 23 behavioral interventions, 8 cognitive interventions, 5 sociological interventions, and 13 interventions that combined behavioral and cognitive approaches (Table 1; Refs. 10, 39–42, 49–53, and 63–73). Most were randomized controlled trials in university settings ($n = 23$). The majority of study populations were composed of white women and women ages 50 years and over. In the studies that reported mammography history, the most frequent rates of ever having had mammography were between 25% and 49%.

Behavioral Interventions. Provider-targeted behavioral interventions included a reminder or office system prompts. Nine used usual care comparison groups, and eight had active comparison groups (two that targeted providers and patients used usual care controls, and four had active controls) (Table 2; Refs. 10, 16, 39–44, and 63–72). Overall, the provider-targeted interventions with usual care controls had an effect of increasing mammography by 13.2% (95% CI, 7.8–18.4. The interventions using active controls were homogeneous, and the overall rate of mammography was 6.8% higher for women whose providers received behavioral interventions, as compared with active controls (95% CI, 4.8–8.7). Sensitivity analyses did not affect these estimates.

Behavioral interventions targeted at both providers and their patients were of comparable effectiveness as those targeting providers alone and showed a 20.5% increase (95% CI, 9.7–31.3) compared to usual care and an 8.9% increase (95% CI, 3.1–14.6) compared to active controls, although these estimates are based on a small number of studies.

Cognitive Interventions. Interventions based on theories of cognitive change typically identify provider attitudes toward screening and breast cancer and provide focused educational material directed at increasing compliance with ordering mammography. The interventions included in this sample used audit with feedback and educational sessions or materials (Table 3; Refs. 47, 48, 64, 66, 72, 74, and 75). Compared to usual care, cognitive interventions increase mammography by 18.6% (95% CI, 12.8–24.4).

A single cognitive intervention was targeted at both providers and patients. This intervention increased mammography use by 16% (95% CI, 7.3–24.7). Finally, three interventions targeted patients and providers in communities using cognitive strategies and increased screening by 9.6% (95% CI, 3.4–15.8).

[3] The abbreviation used is: CI, confidence interval.

Table 1 Characteristics of intervention studies included in meta-analysis (n = 35)

	No.	Percentage (%)	Reference no.
Type of intervention[a]			
Targeting providers alone			
Behavioral			
Usual care control	9	18.4	39, 40, 63–68, 72
Active control	8	16.3	10, 41, 43, 44, 69–71
Cognitive			
Usual care control	4	8.2	64, 66, 72, 74
Cognitive and behavioral			
Usual care control	4	8.2	64, 72, 77, 78
Sociological			
Usual care control	2	4.1	49, 50
Active control	3	6.1	51–53
Targeting providers and patients			
Cognitive			
Usual care control	1	2.0	66
Cognitive and behavioral			
Usual care control	4	8.2	45, 54, 66, 74
Active control	2	4.1	46, 52
Behavioral			
Usual care control	2	4.1	40, 67
Active control	4	8.2	10, 16, 42, 69
Targeting communities			
Cognitive			
Usual care	3	6.1	47, 48, 75
Behavioral and cognitive			
Usual care control	3	6.1	55, 56, 58
Study design[b]			
Randomized control trial	23	65.7	10, 39–41, 63–67, 69–71, 77 16, 42, 43, 47, 50, 52–54, 68, 72
Concurrently controlled trial	12	34.3	44–46, 48, 49, 51, 55, 56, 58, 74, 75, 78
Outcome measure[b,c]			
Completed mammogram from radiology reports	3	8.6	40, 54, 77
Chart review/patient record	21	60.0	10, 39, 64–69, 72 16, 41–44, 51, 54, 74
Patient self-report	7	20.0	45–48, 56, 58, 75
Ordered/response to reminder	6	17.1	52, 55, 63, 70, 71, 78
Setting[b]			
University	10	28.6	40, 41, 63–67, 69–71, 74, 77, 78
Community	25	71.4	10, 42–44, 49, 50, 52, 53, 68, 72 16, 45–48, 54–56, 58, 75
Patient age (yrs)[b,c]			
40–49	16	45.7	10, 42, 43, 48, 49, 65–70, 72, 78 47, 54, 56
50–59	31	88.6	10, 40–42, 63, 65–71, 77 16, 43–46, 49, 50, 53, 72, 74, 75, 78 47, 48, 55, 56, 58, 73
60+	28	80.0	10, 39, 40, 42, 43, 63, 65–70 16, 44–49, 51, 52, 72, 74, 75 55, 56, 58
Not stated	1	2.9	64
Race[b,c]			
>30% white	13	37.1	40, 45–48, 50, 52, 67, 74, 75, 78 68
>30% black	11	31.4	10, 41, 43, 49, 51, 52, 63, 67, 69, 70, 74
>30% Asian	4	11.4	63, 65, 66, 78
Not stated	12	34.3	16, 39, 42, 44, 53–56, 58, 64, 72, 77
Proportion with prior mammograms[b,d]			
0–24%	4	11.4	42, 51, 69, 75
25–49%	13	37.1	10, 42, 44, 46, 50, 52, 54, 56, 66, 68, 70, 75 78
50–74%	7	20	10, 43, 45, 48, 49, 58, 78
Not stated	15	42.9	16, 39–41, 53, 63–65, 67, 71, 72, 74, 77 47, 55

[a] Denominator is the number of interventions.
[b] Denominator is the number of studies.
[c] Categories may total more than 100% because some studies had multiple interventions or populations.
[d] Adherent at baseline or within the past 2 years.

Table 2 Behavioral interventions

	Reference no.	Sample size		Women screened		Effect	95% CI
		Intervention	Control	Intervention	Control		
Provider-targeted behavioral interventions with usual care control	63	NE[a]	NE	8%	2%	6	NE
	64	385	385	85 (22%)	23 (6%)	16	(11.2–20.8)
	65[b]	116	116	37 (32%)	14 (12%)	20	(10.0–30.0)
	66[b]	432	432	264 (61%)[c]	194 (45%)[c]	16	(9.4–22.6)
	67[b]	76	85	23 (30%)	9 (11%)	20	(7.5–31.9)
	68[b]	710	710	285 (40%)[c]	248 (35%)[c]	5	(−0.03–10.03)
	39[b]	32	23	5 (16%)	1 (4%)	11.3	(−3.7–26.3)
	40[b]	14	43	1 (7%)	2 (5%)	2	(−11.8–16.8)
	72[b]	NE	NE	77%	57%	20	NE
Summary	Q-statistic 16.5					13.2	(7.8–18.4)
Provider-targeted interventions with active controls	70[b]	639	623	173 (27%)	131 (21%)	6	(1.3–10.7)
	69[b]	345	266	108 (31%)	73 (27%)	4	(−3.4–11.0)
	41[b]	2,654	2,654	1433 (54%)	1247 (47%)	7	(4.3–9.7)
	71[b]	341	313	112 (33%)	95 (30%)	2.4	(−4.7–9.5)
	10[b]	370	381	118 (32%)	97 (25%)	6.6	(0.1–13.1)
	43[b]	600	625	266 (44.3%)	222 (35.5%)	8.8	(3.3–14.3)
	44[d]	3372	4308	Pre, 597 (17.7%) Post, 1612 (47.9%)	Pre, 482 (11.2%) Post, 1490 (34.6%)	6.8	(4.1–9.5)
	44	3746	4308	Pre, 472 (13%) Post, 1528 (41%)	Pre, 482 (11%) Post, 1490 (35%)	4.8	(2.2–7.3)
Summary	Q-statistic 17.4					6.8	(4.8–8.7)
Provider and patient interventions with usual care controls	67[b]	61	85	19 (31%)	9 (11%)	21	(7.2–33.8)
	40	24	43	6 (25%)	2 (5%)	20	(1.5–38.5)
Summary	Q-statistic 0.0					20.5	(9.7–31.3)
Provider and patient interventions with active controls	69[b]	332	266	90 (27%)	73 (27%)	−0.3	(−7.5–6.9)
	42[b]	1382	1343	732 (53%)	551 (41%)	12	(9.4–14.6)
	10[b]	388	381	122 (32%)	97 (25%)	6.1	(−0.3–12.5)
	16[b]	1171	1171	362 (31%)	187 (16%)	14.9	(11.5–18.3)
Summary	Q-statistic 17.3					8.9	(3.1–14.6)

[a] NE, not evaluable.
[b] Random control group.
[c] Performance score. Pre, preintervention; Post, postintervention.
[d] Nonrandomized concurrent control group.

Sociological Interventions. We identified five sociological interventions designed to increase mammography screening (Table 4; Refs. 49–53 and 76). These provider-targeted sociological interventions used nurse-based interventions or reorganization of the clinic. These interventions were heterogeneous; most of the heterogeneity was associated with a single intervention (50). Omitting that study, sociologic interventions improved mammography utilization by 13.1% (95% CI, 6.8–19.3). Including the one study that was heterogenous (Q = 34.0) decreased the effect size only slightly to 11.1%, with a wider CI (95% CI, 0.2–22.1).

Interventions with Combined Modalities. In interventions that combined cognitive and behavioral strategies to reach providers, the combined effect was a 21.0% increase in mammography utilization (95% CI, 8.8–33.6) in contrast to usual care (Table 5; Refs. 45, 46, 52, 54–56, 58, 64, 66, 74, 77, and 78). When behavioral and cognitive strategies targeted at both providers and patients were combined, these studies were heterogeneous (Q = 24.2). Eliminating the study associated with heterogeneity (54) led to a combined increase in mammography utilization of 16.1% (95% CI, 11.6–20.7). Finally, when cognitive and behavioral strategies are targeted to patients and providers in communities, interventions are no longer effective (1.1% increase; 95% CI, −6.8–9.0).

Discussion

Interventions designed to enhance provider ordering or recommendations for mammography are all generally effective in increasing screening rates, regardless of approach. Behavioral interventions increased screening by 13.2% (95% CI, 7.8–18.4) compared with usual care and by 6.8% (95% CI, 4.8–8.7) compared with active controls. Cognitive intervention strategies improved mammography rates by 18.6% (95% CI, 12.8–24.4), and sociological interventions also had an effect of similar magnitude on screening rates (13.1% increase, 95% CI, 6.8–19.3). In all cases, interventions were more effective in increasing mammography use when compared with usual care than with active controls. Interestingly, strategies that targeted both patients and providers were not significantly more effective than those targeting providers alone. Thus, decisions on the ultimate selection of an intervention to improve mammography

Table 3 Cognitive interventions

	Reference no.	Sample size		Women screened		Effect	95% CI
		Intervention	Control	Intervention	Control		
Provider-targeted cognitive interventions usual care controls	66[a]	432	432	285 (66%)[b]	194 (45%)[b]	21	(14.7–27.6)
	64[a]	385	385	77 (20%)	23 (6%)	14	(9.4–18.6)
	74[c]	Post, 152[d]	Post, 227	Pre, 34 (22%) Post, 94 (62%)	Pre, 45 (20%) Post, 81 (36%)	23.7	(10.6–36.6)
	72[a]	NE	NE	71%	57%	14	NE
Summary	Q-statistic 4.3					18.6	(12.8–24.4)
Provider and patient-targeted interventions usual care controls	66	216	216	164 (76%)[b]	130 (60%)[b]	16	(7.3–24.7)
Community-targeted interventions active controls	75	Pre, 487 Post, 486	Pre, 484 Post, 484	Pre, 268 (55%) Post, 365 (75%)	Pre, 266 (55%) Post, 295 (61%)	14	(5.5–22.5)
	48[c]	Pre, 331 Post, 461	Pre, 333 Post, 420	Pre, 163 (49%) Post, 241 (52%)	Pre, 183 (55%) Post, 241 (57%)	0.7	(−9.3–11.4)
	47[a]	270	270	221 (82%)	194 (72%)	10.0	(3.0–17.0)
Summary	Q-statistic 7.8					9.6	(3.4–15.8)

[a] Random control group.
[b] Performance score.
[c] Nonrandomized concurrent control group.
[d] Post, postintervention; Pre, preintervention; NE, not evaluable.

Table 4 Sociological interventions

	Reference no.	Sample size		Percentage of women screened		Effect	95% CI
		Intervention	Control	Intervention	Control		
Provider-targeted sociological interventions usual care controls	49[a]	Pre, 327[b] Post, 253	Pre, 739 Post, 739	Pre, 222 (68%) Post, 195 (77%)	Pre, 488 (66%) Post, 484 (67%) and 64% (65.5%)	9.5	(0.8–18.2)
	50[a]	1536	1338	502 (32.7%)	455 (34.0%)	−1.3	(−4.8–2.2)
Active controls	51[a]	Pre, 199 Post, 160	Pre, 155 Post, 159	Pre, 18.3% (36) Post, 40.0 (64)	Pre, 18.1% (28) Post, 18.2% (29)	21.6	(9.0–34.2)
	52[c]	267	268	30.9% (83)	19.4% (52)	11.5	(4.2–18.8)
	53	NE	NE	31.2%	22.8%	8.4	NE
Summary	Q-statistic 3.0					13.1	(6.8–19.3)

[a] Nonrandomized concurrent control group.
[b] Pre, preintervention; Post, postintervention; NE, not evaluable.
[c] Random control group.

receipt that targets providers should depend on feasibility, resources, expertise, and cost effectiveness.

Recent national estimates indicate that 56% of asymptomatic women over the age of 50 years have received a screening mammogram within the past 2 years (79). Although this figure is higher than in the previous decade (80), potentially as a result of increased attention from managed care and other organizations to practice profiles and physician report cards (81), many women are still not screened. With the use of provider-directed interventions, such as educational systems (82), an additional 2.25 to 6 million women would be screened, with a resultant down-staging of disease and an improvement in morbidity and mortality.

Our result of an average of a 6–21% increase in screening with provider interventions is similar to that found in our prior meta-analysis. In the earlier study, which separated interventions into similar categories, we noted that mammography rates could be increased by 6–14% (7). The magnitude of effect seen with provider-targeted interventions is similar to that seen for patient-specific interventions (83).

Contrary to intuition, the combination of provider- and patient-targeted strategies was not significantly more effective than provider-targeted interventions alone. This is also the case for interventions using multiple approaches (behavioral and cognitive) rather than single approaches. Possible explanations for the lack of synergy between these two effective individual approaches include lack of foundation in theories of patient-provider communication and/or theoretical models of behavior, inability to ensure full penetrance into both target populations, lack of ability to ensure fidelity of complex interventions, or true negative synergy through increased patient anxiety or misperceptions. This will be an important area for investigation in future factorially designed controlled trials.

There are some methodological limitations with the meta-analysis reported here, including heterogeneity among studies that were combined, differences in patient populations, inconsistencies in the unit of analysis used to calculate intervention effectiveness, multiple interventions from the same study, the combination of multiple measures of mammography utilization, inability to evaluate the actual penetrance of intervention to

Table 5 Cognitive and behavioral interventions

	Reference no.	Sample size		Women screened		Effect	95% CI
		Intervention	Control	Intervention	Control		
Provider-targeted interventions usual care control	77[a]	290	138	93 (32%)	6 (4%)	28	(21.7–34.3)
	64[a]	385	385	81 (21%)	23 (6%)	15	(10.4–19.8)
	78[b]	NE[c]	NE	10.8%	1.7%	9.1	NE
	72[a]	NE	NE	78%	57%	21	NE
Summary	Q = 9.8					21	(8.8–33.6)
Provider and patient-targeted interventions usual care controls	74[b]	129	227	Pre, 31 (24%) Post, 70 (54%)	Pre, 45 (20%) Post, 81 (36%)	13.4	(1.7–25.1)
	66[a]	216	216	162 (75%)[d]	108 (50%)[d]	25	(16.2–33.8)
	46[c]	Pre, 451 Post, 445	Pre, 449 Post, 440	Pre, 185 (41%) Post, 276 (62%)	Pre, 175 (39%) Post, 189 (43%)	17.0	(7.9–26.1)
	54[a,e]	227	194	56 (24.6%)	56 (28.7%)	−4.1	(−12.6–4.4)
Active control	52[a]	267	268	76 (28.4%)	52 (19.4%)	9.0	(1.8–16.2)
	45	Pre, 465 Post, 475	Pre, 474 Post, 443	Pre, 184 (40%) Post, 333 (70%)	Pre, 174 (39%) Post, 258 (58%)	11	(2.2–20.0)
Summary	Q = 9.1					16.1	(11.6–20.7)
Community-targeted interventions usual care controls	55[b]	NE	NE	Pre, 46.2% Post, 91.1%	Pre, 62.5% Post, 83.6%	23.8	NE
	56[b]	Pre, 437 Post, 327	Pre, 401 Post, 314	Pre, 133 (30%) Post, 175 (54%)	Pre, 125 (31%) Post, 147 (47%)	7.8	(−2.1–17.7)
	58[b]	Pre, 706 Post, 958	Pre, 555 Post, 739	Pre, 393 (56%) Post, 687 (72%)	Pre, 310 (56%) Post, 550 (74%)	−2.7	(−9.7–4.3)
Summary	Q = 7.7					1.1	(−6.8–9.0)

[a] Random control group.
[b] Nonrandomized concurrent control group.
[c] NE, not evaluable; Pre, preintervention; Post, postintervention.
[d] Performance score.
[e] Excluded from quantitative analysis.

target population (*e.g.*, did individuals in the target population actually receive the intervention), potential patient and provider selection biases, publication bias, and lack of data on intervention durability. We combined data from studies conducted in dissimilar populations or environments in which mammography screening is obtained. We attempted to make the groups of interventions as homogeneous as possible. However, because of a limited number of interventions in some categories, we had limited power to assess homogeneity. To test the effects of any heterogeneity, we used sensitivity analysis to sequentially remove each study and recalculate summary estimates to determine the independent impact of a single study on overall results. Several studies yielded inconsistent results when combined with others as a result of differences in setting (*i.e.*, community providers *versus* university hospitals or clinics; Ref. 68), unit of analysis (50), outcome definition (71), or limited power (40).

All of the interventions reviewed here included control groups of similar women and were grouped according to the mechanism of intervention action. However, there are important differences in the women enrolled in the different types of interventions, which may affect the interpretation and comparison of these results. For example, most studies include white women, although some included minority women. Additionally, several of the studies included populations of women with high rates of previous mammography (10, 13, 84). Thus, comparisons among interventions and adaptation of interventions to dissimilar populations should be approached cautiously.

The majority of studies we identified randomized individual providers to receive either the intervention or control condition. However, some studies randomized providers by practice group (50, 52), yet these data are combined as if randomization occurred individually, and all observations are independent. Women treated by the same provider may be more similar in terms of mammography utilization than those recruited from a random sample or those that received a standardized intervention. If analyses were to incorporate the actual unit of randomization (*e.g.*, practice group) or correlation among individuals, CIs would be wider, but the estimate of intervention effectiveness should remain unchanged.

In several cases, multiple interventions were performed and reported within a single study (52, 64, 66, 67, 69, 72), but they were compared to the same control group. In one group of interventions, behavioral interventions with active control groups, two interventions from the same study are included in the quantitative analysis (44). Because individuals in the control group are counted more than once, assumptions of independence among subjects are violated. To assess the impact on the summary estimates and their interpretation, we recalculated these statistics twice, without one of the interventions each time. Excluding either one of the interventions did not affect the interpretation of summary statistics. In no other case was more than one intervention from a single study included in the calculation of summary statistics.

The studies included here used several mechanisms to identify mammography utilization: (*a*) patient self-report; (*b*) chart audit; (*c*) electronic claims; (*d*) mammography facility records of actual screening; and (*e*) documentation of provider ordering of a mammogram. We considered these different sources to be equivalent for the purposes of analysis, although this is not necessarily the case. Patient self-report of mammography has been described as highly correlated with mammography use reported in patient charts or claims, but it is likely to

overstate utilization (59, 85–87), particularly among low-income minority populations (88). However, women randomized to intervention and control provider groups might be equally likely to overstate mammography utilization, so whereas the absolute estimate of mammography utilization might be influenced by the reporting source, the relative estimate (intervention *versus* control) is less likely to be affected. In studies that reported provider ordering and actual patient completion of screening, interventions were more effective in increasing rates of ordering than rates of completion (50, 74). Again, this may overestimate the magnitude of effectiveness of interventions, but not the relative efficacy of each strategy.

The effectiveness reported here may not reflect the potential efficacy if the intervention had 100% penetrance. However, we cannot evaluate the degree of penetrance or the minimum level required to increase rates of screening. Women and providers participating in the interventions may differ systematically from the nonparticipants. For example, if the participants tend to be health seekers who comply with screening recommendations to a greater degree than nonparticipants, then intervention effectiveness will be overstated. Likewise, if participating providers are more likely to order screening than those refusing to participate, the results will be an overestimate of true effectiveness. Additionally, the studies identified and included were based on a review of the published literature. Studies with negative or null findings might be less likely to be published and thus less likely to be included in this review. This would result in an overstatement of the effectiveness of interventions to improve rates of mammography screening.

Finally, the long-term effectiveness of these interventions in increasing rates of regular mammography is only rarely reported (22, 26, 30, 89). Improvements in mammography utilization at a single point in time as described in the studies here do not translate directly into reductions in morbidity and mortality from breast cancer. Women must obtain screening annually (90). Even if women do receive regular screening, reductions in morbidity and mortality may not be realized as a result of delays in follow-up after an abnormal test result, incomplete diagnostic work-up, or the lack of adherence to a treatment regimen. Additionally, there may be adverse effects associated with interventions to increase mammography utilization such as increased rates of false positive exams, which are estimated to be as high as 30% among women receiving regular mammography over a 10-year period (91), and associated psychological distress (92).

Overall, all interventions appear to be effective in increasing provider-initiated mammography utilization. The effectiveness of different types of interventions in patient subpopulations such as the elderly, minorities, or those of low income and the costs of providing these interventions are critical areas for research in decreasing the morbidity and mortality associated with breast cancer.

Appendix

The formulas used to calculate variance are shown below. For randomized controlled trials, the formula used was:

$$(P_{\text{screened intervention}} \times P_{\text{unscreened intervention}})/N_{\text{intervention}} + (P_{\text{screened control}} \times P_{\text{unscreened control}})/N_{\text{control}}$$

For nonrandomized concurrently controlled studies, the formula used was:

$$(P_{\text{screened preintervention}} \times P_{\text{unscreened preintervention}})/N_{\text{preintervention}} + (P_{\text{screened postintervention}} \times P_{\text{unscreened postintervention}})/N_{\text{postintervention}} + (P_{\text{screened precontrol}} \times P_{\text{unscreened precontrol}})/N_{\text{precontrol}} + (P_{\text{screened postcontrol}} \times P_{\text{unscreened postcontrol}})/N_{\text{postcontrol}}$$

References

1. Shapiro, S. Periodic screening for breast cancer: the HIP randomized controlled trial. J. Natl. Cancer Inst. Monogr., *22:* 27–30, 1997.

2. Tabar, L., Fagerberg, C. J., Duffy, S., Day, N., Gas, A., and Grontoft, O. Update of the Swedish two-county program of mammographic screening trial. Radiol. Clin. North Am., *30:* 187–210, 1992.

3. Andersson, I., Aspegren, K., Janzon, L., Landberg, T., Lindholm, K., Linell, F., Ljungberg, O., Ranstam, J., and Sigfusson, B. Mammographic screening and mortality from breast cancer: the Malmo mammographic screening trial. Br. Med. J., *297:* 943–948, 1988.

4. Fletcher, S. W., Black, W., Harris, R., Rimer, B. K., and Shapiro, S. Report of the international workshop on screening for breast cancer. J. Natl. Cancer Inst., *85:* 1644–1656, 1993.

5. Grady, K. E., Lemkau, J. P., McVay, J. M., and Reisine, S. T. The importance of physician encouragement in breast cancer screening of older women. Prev. Med., *21:* 766–780, 1992.

6. Fox, S. A., and Stein, J. A. The effect of physician-patient communication on mammography utilization by different ethnic groups. Med. Care (Phila.), *29:* 1065–1082, 1991.

7. Mandelblatt, J., and Kanetsky, P. A. Effectiveness of interventions to enhance physician screening for breast cancer. J. Fam. Pract., *40:* 162–170, 1995.

8. Mayer, J. A., Clapp, E. J., Bartholomew, S., and Offer, J. Facility-based inreach strategies to promote annual mammograms. Am. J. Prev. Med., *10:* 353–356, 1994.

9. Mohler, P. J. Enhancing compliance with screening mammography recommendations: a clinical trial in a primary care office. Fam. Med., *27:* 117–121, 1995.

10. Burack, R. C., Gimotty, P. A., George, J., Simon, M. S., Dews, P., and Moncrease, A. The effect of patient and physician reminders on use of screening mammography in a health maintenance organization. Results of a randomized controlled trial. Cancer (Phila.), *78:* 1708–1721, 1996.

11. Lantz, P. M., Stencil, D., Lippert, M. T., Beversdorf, S., Jaros, L., and Remington, P. L. Breast and cervical cancer screening in a low-income managed care sample: the efficacy of physician letters and phone calls. Am. J. Public Health, *85:* 834–836, 1995.

12. Taplin, S. H., Anderman, C., Grothaus, L., Curry, S., and Montano, D. Using physician correspondence and postcard reminders to promote mammography use. Am. J. Public Health, *84:* 571–574, 1994.

13. Kendall, C., and Hailey, B. J. The relative effectiveness of three reminder letters on making and keeping mammogram appointments. Behav. Med., *19:* 29–34, 1993.

14. King, E. S., Rimer, B. K., Seay, J., Balshem, A., and Engstrom, P. F. Promoting mammography use through progressive interventions: is it effective? Am. J. Public Health, *84:* 104–106, 1994.

15. Margolis, K. L., and Menart, T. C. A test of two interventions to improve compliance with scheduled mammography appointments. J. Gen. Intern. Med., *11:* 539–541, 1996.

16. Somkin, C. P., Hiatt, R. A., Hurley, L. B., Gruskin, E., Ackerson, L., and Larson, P. The effect of patient and provider reminders on mammography and Papanicolaou smear screening in large health maintenance organization. Arch. Intern. Med., *157:* 1658–1664, 1997.

17. King, E., Rimer, B. K., Benincasa, T., Harrop, C., Amfoh, K., Bonney, G., Kornguth, P., Demark-Wahnefried, W., Strigo, T., and Engstrom, P. Strategies to encourage mammography use among women in senior citizens housing facilities. J. Cancer Educ., *13:* 108–115, 1998.

18. Mayer, J. A., Jones, J. A., Eckhardt, L. E., Haliday, J., Bartholomew, S., Slymen, D. J., and Hovell, M. F. Evaluation of a worksite mammography program. Am. J. Prev. Med., *9:* 244–249, 1993.

19. Curry, S. J., Taplin, S. H., Anderman, C., Barlow, W. E., and McBride, C. A randomized trial of the impact of risk assessment and feedback on participation in mammography screening. Prev. Med., *22:* 350–360, 1993.

20. Champion, V. L. Strategies to increase mammography utilization. Med. Care (Phila.), *32:* 118–129, 1994.

21. Skinner, C. S., Strecher, V. J., and Hospers, H. Physician's recommendations for mammography: do tailored messages make a difference? Am. J. Public Health, *84:* 43–49, 1994.

22. Davis, T. C., Hetkel, H., Arnold, C., Nandy, I., Jackson, R. H., and Murphy, P. W. Intervention to increase mammography utilization in a public hospital. J. Gen. Intern. Med., *13:* 230–233, 1998.

23. Aiken, L. S., West, S. G., Woodward, C. K., Reno, R. R., and Reynolds, K. D. Increasing screening mammography in asymptomatic women: evaluation of a second-generation, theory-based program. Health Psychol., *13:* 526–538, 1994.

24. Rothman, A. J., Salovey, P., Turvey, C., and Fishkin, S. A. Attributions of responsibility and persuasion: increasing mammography utilization among women over 40 with an internally oriented message. Health Psychol., *12:* 39–47, 1993.

25. Bastani, R., Marcus, A. C., Maxwell, A. E., Das, I. P., and Yan, K. X. Evaluation of an intervention to increase mammography screening in Los Angeles. Prev. Med., *23:* 83–90, 1994.

26. Banks, S. M., Salovey, P., Greener, S., Rothman, A. J., Moyer, A., Beauvais, J., and Epel, E. The effects of message framing on mammography utilization. Health Psychol., *14:* 178–184, 1995.

27. Marcus, A. C., Bastani, R., Reardon, K., Karlins, S., Das, I. P., Van Herle, M. P., McClatchey, M. W., and Crane, L. A. Proactive screening mammography counseling within the Cancer Information Service: results from a randomized trial. J. Natl. Cancer Inst. Monogr., *14:* 119–129, 1993.

28. Taylor, V. M., Taplin, S. H., Urban, N., White, E., Mahloch, J., Majer, K., McLerran, D., and Peacock, S. Community organization to promote breast cancer screening ordering by primary care physicians. J. Community Health, *21:* 277–291, 1996.

29. Fox, S. A., Stein, J. A., Gonzalez, R. E., Farrenkopf, M., and Dellinger, A. A trial to increase mammography utilization among Los Angeles Hispanic women. J. Health Care Poor Underserved, *9:* 309–321, 1998.

30. Margolis, K. L., Lurie, N., McGovern, P. G., Tyrrell, M., and Slater, J. S. Increasing breast and cervical cancer screening in low-income women. J. Gen. Intern. Med., *13:* 515–521, 1998.

31. Davis, N. A., Nash, E., Bailey, C., Lewis, M. J., Rimer, B. K., and Koplan, J. P. Evaluation of three methods for improving mammography rates in a managed care plan. Am. J. Prev. Med., *13:* 298–302, 1997.

32. Houts, P. S., Wojtkowiak, S. L., Simmonds, M. A., Weinberg, G. B., and Heitjan, D. F. Using a state cancer registry to increase screening behaviors of sisters and daughters of breast cancer patients. Am. J. Public Health, *81:* 386–388, 1991.

33. Calle, E. E., Miracle-McMahill, H. L., Moss, R. E., and Heath, C. W., Jr. Personal contact from friends to increase mammography usage. Am. J. Prev. Med., *10:* 361–366, 1994.

34. Janz, N. K., Schottenfeld, D., Doerr, K. M., Selig, S. M., Dunn, R. L., Strawderman, M., and Levine, P. A. A two-step intervention to increase mammography among women aged 65 and older. Am. J. Public Health, *87:* 1683–1686, 1997.

35. Suarez, L., Roche, R. A., Pulley, L., Weiss, N. S., Goldman, D., and Simpson, D. M. Why a peer intervention program for Mexican-American women failed to modify the secular trend in cancer screening. Am. J. Prev. Med., *13:* 411–417, 1997.

36. Sung, J. F. C., Blumenthal, D. S., Coates, R. J., Williams, J. E., Alema-Mensah, E., and Liff, J. M. Effect of cancer screening intervention conducted by lay health workers among inner-city women. Am. J. Prev. Med., *13:* 51–57, 1997.

37. Weber, B. E., and Reilly, B. M. Enhanced mammography use in the inner city: a randomized trial of intensive case management. Arch. Intern. Med., *157:* 2345–2349, 1997.

38. Navarro, A. M., Senn, K. L., McNicholas, L. J., Kaplan, R. M., Roppe, B., and Campo, M. C. Por La Vida model intervention enhances use of cancer screening test among Latinas. Am. J. Prev. Med., *15:* 32–41, 1998.

39. Cowan, J. A., Heckerline, P. S., and Parker, J. B. Effect of a fact sheet reminder on performance of the periodic health examination: a randomized controlled trial. Am. J. Prev. Med., *8:* 104–109, 1992.

40. Landis, S. E., Hulkower, S. D., and Pierson, S. Enhancing adherence with mammography through patient letters and physician prompts: a pilot study. North Carolina Med. J., *53:* 575–578, 1992.

41. Litzelman, D. K., Dittus, R. S., Miller, M. E., and Tierney, W. M. Requiring physicians to respond to computerized reminders improves their compliance with preventive care protocols. J. Gen. Intern. Med., *7:* 311–317, 1993.

42. Burack, R. C., Gimotty, P. A., George, J., Stengle, W., Warbasse, L., and Moncrease, A. Promoting screening mammography in inner-city settings: a randomized controlled trial of computerized reminders as a component of a program to facilitate mammography. Med. Care (Phila.), *32:* 609–624, 1994.

43. Burack, R. C., and Gimotty, P. A. Promoting screening mammography in an inner-city setting: the sustained effectiveness of computerized reminders in a randomized controlled trial. Med. Care (Phila.), *35:* 921–931, 1997.

44. Grady, K. E., Lemkau, J. P., Lee, N. R., and Caddell, C. Enhancing mammography referral in primary care. Prev. Med., *26:* 791–800, 1997.

45. Rimer, B. K., Ross, E., Balshem, A., and Engstrom, P. F. The effect of comprehensive breast screening program on self-reported mammography use by primary care physicians and women in a health maintenance organization. J. Am. Board Fam. Pract., *6:* 443–451, 1993.

46. Trock, B., Rimer, B. K., King, E., Balshem, A., Cristinzio, C. S., and Engstrom, P. F. Impact of an HMO-based intervention to increase mammography utilization. Cancer Epidemiol. Biomark. Prev., *2:* 151–156, 1993.

47. Flynn, B. S., Gavin, P., Worden, J. K., Ashikaga, T., Gautam, S., and Carpenter, J. Community education programs to promote mammography participation in rural New York state. Prev. Med., *26:* 102–108, 1997.

48. Gardiner, J. C., Mullan, P. B., Rosenman, K. D., Zhu, Z., and Swanson, M. Mammography usage and knowledge about breast cancer in a Michigan farm population before and after an educational intervention. J. Cancer Educ., *10:* 155–162, 1995.

49. McCarthy, B. D., Yood, M. U., Bolton, M. B., Boohaker, E. A., MacWilliam, C. H., and Young, M. J. Redesigning primary care processes to improve the offering of mammography: the use of clinic protocols by nonphysicians. J. Gen. Intern. Med., *12:* 357–363, 1997.

50. Kinsinger, L. S., Harris, R., Qaqish, B., Strecher, V., and Kaluzny, A. Using an office system intervention to increase breast cancer screening. J. Gen. Intern. Med., *13:* 507–514, 1998.

51. Mandelblatt, J. S., Traxler, M., Lakin, P., Thomas, L., Chauhan, P., Matseoane, S., and Kanetsky, P. A nurse practitioner intervention to increase breast and cervical cancer screening for poor, elderly black women. J. Gen. Intern. Med., *8:* 173–178, 1993.

52. Herman, C. J., Speroff, T., and Cebul, R. D. Improving compliance with breast cancer screening in older women. Arch. Intern. Med., *155:* 717–722, 1995.

53. Williams, R. B., Boles, M., and Johnson, R. E. A patient-initiated system for preventive health care: a randomized trial in community-based primary care practices. Arch. Fam. Med., *7:* 338–345, 1998.

54. Manfredi, C., Czaja, R., Freels, S., Trubitt, M., Warnecke, R., and Lacey, L. Prescribe for health: improving cancer screening in physician practices serving low-income and minority populations. Arch. Fam. Med., *7:* 329–337, 1998.

55. Costanza, M. E., Zapka, J. G., Harris, D. R., Hosmer, D., Barth, R., Gaw, V. P., Greene, H. L., and Stoddard, A. Impact of a physician intervention program to increase breast cancer screening. Cancer Epidemiol. Biomark. Prev., *1:* 581–589, 1992.

56. Zapka, J. G., Costanza, M. E., Harris, D. R., Hosmer, D., Stoddard, A., Barth, R., and Gaw, V. Impact of a breast cancer screening community intervention. Prev. Med., *22:* 34–53, 1993.

57. King, E. S., Rimer, B. K., Seay, J., Balshem, A., and Engstrom, P. F. Promoting mammography use through progressive interventions: is it effective? Am. J. Public Health, *84:* 104–106, 1994.

58. Urban, N., Taplin, S. H., Taylor, V., Peacock, S., Anderson, G., Conrad, D., Etzioni, R., White, E., Montano, D. E., Mahloch, J., and Majer, K. Community organization to promote cancer screening among women ages 50–75. Prev. Med., *24:* 477–484, 1995.

59. Montano, D. E., and Phillips, W. R. Cancer screening by primary care physicians: a comparison of rates obtained from physician self-report, patient survey, and chart adult. Am. J. Public Health, *85:* 795–800, 1995.

60. Fineberg, M. V., Funkhouser, A. R., and Marks, M. Variation in medical practice: a review of the literature. *In:* J. M. Eisenberg (ed.), Doctor's Decisions and the Cost of Medical Care, pp. 137–138. Ann Arbor, MI: Health Administration Press Perspectives, 1986.

61. DeSimonian, R., and Laird, N. Meta-analysis in clinical trials. Controlled Clin. Trials, *7:* 177–188, 1986.

62. Lau, J. Meta-Analyst Computer Program, copyright John Lau, 1994.

63. McDonald, C. J., Hui, S. L., Smith, D. M., Tierney, W. M., Cohen, S. J., Weinberger, M., and McCabe, G. P. Reminders to physicians from an introspective computer medical record. A two-year randomized trial. Ann. Intern. Med., *100:* 130–138, 1984.

64. Tierney, W. M., Hui, S. L., and McDonald, C. J. Delayed feedback of physician performance *versus* immediate reminders to perform preventive care. Med. Care (Phila.), *24:* 659–666, 1986.

65. Cheney, C., and Ramsdell, J. W. Effect of medical records' checklists on implementation of periodic health measures. Am. J. Med., *83:* 129–136, 1987.

66. McPhee, S. J., Bird, J. A., Jenkins, C. N. H., and Fordham, D. Promoting cancer screening: a randomized, controlled trial of three interventions. Arch. Intern. Med., *149:* 1866–1872, 1989.

67. Becker, D. M., Gomez, E. B., Kaiser, D. L., Yoshihasi, A., and Hodge, R. Improving preventive care at a medical clinic: how can the patient help? Am. J. Prev. Med., *5:* 353–359, 1989.

68. McPhee, S. J., Bird, J. A., Fordham, D., Rodnick, J. E., and Osborn, E. H. Promoting cancer prevention activities by primary care physicians: results of a randomized, controlled trial. J. Am. Med. Assoc., *266:* 538–544, 1991.

69. Ornstein, S. M., Garr, D. R., Jenkins, R. G., Rust, P. F., and Arnon, A. Computer-generated physician and patient reminders: tools to improve population adherence to selected preventive services. J. Fam. Pract., *32:* 82–90, 1991.

70. Chambers, C. V., Balaban, D. J., Carlson, B. L., Ungemack, J. A., and Grasberger, D. M. Microcomputer-generated reminders: improving the compliance of primary care physicians with screening guidelines. J. Fam. Pract., *29:* 273–280, 1989.

71. Tape, T. G., and Campbell, J. R. Computerized medical records and preventive health care: success depends on many factors. Am. J. Med., *94:* 619–625, 1993.

72. Dietrich, A. J., O'Connor, G. T., Keller, A., Carney, P. A., Levy, D., and Whaley, F. S. Cancer: improving early detection and prevention. A community practice randomized trial. Br. Med. J., 3*04:* 687–691, 1992.

73. Manfredi, C., Czaja, R., Price, J., Buis, M., and Janiszewski, R. Cancer patients' search for information. J. Natl. Cancer Inst., *14:* 93–104, 1993.

74. Nattinger, A. B., Panzer, R. J., and Janus, J. Improving the utilization of screening mammography in primary care practices. Arch. Intern. Med., *149:* 2087–2092, 1989.

75. Fletcher, S. W., Harris, R. P., Gonzalez, J. J., Degnan, D., Lannin, D. R., Strecher, V. J., Pilgrim, C., Quade, D., Earp, J. A., and Clark, R. L. Increasing mammography utilization: a controlled study. J. Natl. Cancer Inst., *85:* 112–120, 1993.

76. Allen, C., Cox, E. B., Manton, K. G., and Cohen, H. J. Breast cancer in the elderly-current patterns of care. J. Am. Geriatr. Soc., *34:* 637–642, 1986.

77. Cohen, D. I., Littenberg, B., Wetzel, C., and Neuhauser, D. Improving physician compliance with preventive medicine guidelines. Med. Care (Phila.), *20:* 1040–1045, 1982.

78. Fox, S., Tsou, C. V., and Klos, D. S. An intervention to increase mammography screening by residents in family practice. J. Fam. Pract., *20:* 467–471, 1985.

79. Potosky, A. L., Breen, N., Graubard, B. I., and Parsons, P. E. The association between health care coverage and the use of cancer screening tests. Results from the 1992 National Health Interview Survey. Med. Care (Phila.), *36:* 257–270, 1998.

80. Breen, N., and Kessler, L. Changes in the use of screening mammography: evidence from the 1987 and 1990 National Health Interview Surveys. Am. J. Public Health, *84:* 62–67, 1994.

81. American Society of Clinical Oncology. Outcomes of cancer treatment for technology assessment and cancer treatment guidelines. J. Clin. Oncol., *14:* 671–679, 1996.

82. Davis, D. A., Thomson, M. A., Oxman, A. D., and Haynes, R. B. Changing physician performance: a systematic review of the effect of continuing medical education strategies. J. Am. Med. Assoc., *274:* 700–705, 1995.

83. Yabroff, K. R., and Mandelblatt, J. S. Interventions targeted to patients to increase mammography use. Cancer Epidemiol. Biomark. Prev., *8:* 749–757, 1999.

84. Turner, K. M., Wilson, B. J., and Gilbert, F. J. Improving breast cancer screening uptake: persuading initial non-attenders to attend. J. Med. Screen., *1:* 199–202, 1994.

85. Zapka, J. G., Bigelow, C., Hurley, T., Ford, L. D., Egelhofer, J., Cloud, W. M., and Sachsse, E. Mammography use among sociodemographically diverse women: the accuracy of self-report. Am. J. Public Health, *86:* 1016–1021, 1996.

86. McGovern, P. G., Lurie, N., Margolis, K. L., and Slater, J. S. Accuracy of self-report of mammography and pap smear in a low-income urban population. Am. J. Prev. Med., *14:* 201–208, 1998.

87. Paskett, E. D., Tatum, C. M., Mack, D. W., Hoen, H., Case, L. D., and Velez, R. Validation of self-reported breast and cervical cancer screening tests among low-income minority women. Cancer Epidemiol. Biomark. Prev., *5:* 721–726, 1996.

88. Champion, V. L., Menon, U., McQuillen, D. H., and Scott, C. Validity of self-reported mammography in low-income African-American women. Am. J. Prev. Med., *14:* 111–117, 1998.

89. Dickey, L. L., and Petitti, D. A patient-held minirecord to promote adult preventive care. J. Fam. Pract., *34:* 457–463, 1992.

90. United States Preventive Services Task Force. Guide to Clinical Preventive Services: Report of the United States Preventive Services Task Force. Baltimore, MD: Williams & Wilkins, 1996.

91. Elmore, J. G., Barton, M. B., Moceri, V. M., Polk, S., Arena, P. J., and Fletcher, S. W. Ten-year risk of false positive screening mammograms and clinical breast exams. N. Engl. J. Med., *338:* 1089–1096, 1998.

92. Lerman, C., Trock, B., Rimer, B. K., Boyce, A., Jepson, C., and Engstrom, P. F. Psychological and behavioral implications of abnormal mammograms. Ann. Intern. Med., *114:* 657–661, 1991.

Effectiveness of Interventions Designed to Increase Mammography Use: A Meta-Analysis of Provider-targeted Strategies

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