

ORIGINAL ARTICLES

Effectiveness of Interventions to Increase Papanicolaou Smear Use

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Background: Many women fail to adhere to Papanicolaou smear screening guidelines. Although many interventions have been developed to increase screening, the effectiveness of different types of interventions is unclear.

Methods: We performed a systematic review of interventions to increase Papanicolaou smear use published between 1980 and April 2001 and included concurrently or randomized controlled studies with defined outcomes. Interventions were classified as targeted to patients, providers, patients and providers, or health care systems and as behavioral, cognitive, sociologic, or a combination based on the expected action of the intervention. Effect sizes and 95% confidence intervals were calculated for each intervention.

Results: Forty-six studies with 63 separate interventions were included. Most interventions increased Papanicolaou smear use, although in many cases the increase was not statistically significant. Behavioral interventions targeted to patients (eg, mailed or telephone reminders) increased Papanicolaou smear use by up to 18.8%; cognitive and sociologic interventions were only marginally effective, although a single culturally specific, sociologic intervention using a lay health worker increased use by 18.0% (95% confidence interval [CI]: 7.6, 28.4). Provider-targeted interventions were heterogeneous. Interventions that targeted both patients and providers did not appear to be any more effective than interventions targeted to either patients or providers alone. One of the most effective interventions, which introduced a system change by integrating a nurse-practitioner and offered same-day screening, increased screening by 32.7% (95% CI: 20.5, 44.9).

Conclusions: Overall, most interventions increased Papanicolaou smear use, although there was tremendous variability in their effectiveness. Selection of intervention strategies will depend on provider and patient population characteristics and feasibility of implementation. (J Am Board Fam Pract 2003; 16:188–203.)

Screening with regular Papanicolaou smears can decrease not only cervical cancer mortality but also the incidence of invasive disease.^{1,2} Despite in-

creases in recent Papanicolaou smear use during the past two decades,^{3,4} with national estimates of approximately 80% within the past 3 years,⁴ some women still fail to adhere to recommended Papanicolaou smear screening guidelines,^{3–26} are found to have advanced disease, and die of invasive cervical cancer.^{27–29} Thus, the potential benefits of routine screening are not being fully realized. Increasing the provision of Papanicolaou smear counseling by primary care providers and, ultimately, routine Papanicolaou smear use are important components of current *Healthy People 2010* goals for reducing cervical cancer mortality.³⁰

Physician recommendation is one of the strongest predictors of screening use,^{13,17,31–37} but in many cases, women report that their provider did not recommend Papanicolaou smears.^{5,7,18,38–45} Explanations for this behavior include lack of time, busy schedules and forgetfulness,^{46,47} beliefs about

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screening efficacy in the absence of symptoms or concern about proficiency,^{31,48} or confusion about conflicting professional recommendations.⁴⁶ In the absence of a physician recommendation, patients might assume that screening is unnecessary.

Women who do not receive regular Papanicolaou smears are more likely to be older,^{5-26,49-52} uninsured or underinsured,* lack a usual source of care or regular provider,† and have lower educational attainment or lower household income.‡ Among immigrant women, those who do not speak English or have lower levels of acculturation are also less likely to receive regular Papanicolaou smears.^{16,22,23,52,58,64,65}

Additionally, women might not know about the potential benefits of screening, believe it to be unnecessary in the absence of symptoms,§ fear a potential cancer diagnosis, or believe that cancer cannot be cured.|| Women might also be concerned about inconvenience, discomfort, embarrassment, or pain associated with the test itself.^{7,25,42-45,52,69} Concerns about modesty or cultural restrictions on gynecological examinations by male physicians could exacerbate other barriers to screening.^{22,25,43,66,72-74} Finally, women might know about the need for Papanicolaou smears but have put off receiving a test because of convenience, time constraints, or forgetfulness.^{5,25,38,40,44,59,69}

During the past two decades, results from numerous interventions to increase Papanicolaou smear use have been reported.^{75,76} These interventions focus on increasing rates of provider recommendation, reducing patient barriers to screening, or both. Two reviews provided descriptive information about interventions published before 1998 and whether they were effective^{75,76} but did not provide details about the magnitude of effectiveness. Because of the large numbers of interventions, particularly in the past several years, and differences in study design, populations, and intervention content, it is difficult to know which interventions are most effective in increasing Papanicolaou smear use. This systematic review of the published literature was conducted to update previous re-

views^{74,75} and provide information on the effectiveness of controlled interventions to increase Papanicolaou smear use.

Methods

Study Selection

We used the Ovid search mechanism for MEDLINE to select English language articles published between 1980 and April 2001 on interventions to increase Papanicolaou smear use. The start date of 1980 was chosen because the National Institutes of Health Consensus Conference endorsed routine Papanicolaou smear screening and began to publicize their screening guidelines in that year.⁷⁷ The search strategy used the subject terms “health behavior,” “patient compliance,” “patient acceptance of health care,” “attitude to health,” “health education,” or “health promotion” (N = 75,985) with the subject terms “Papanicolaou smear” or “cervical neoplasms/prevention and control” (N = 1,871). The combination yielded 467 studies. Study abstracts were reviewed for evidence of random or concurrent assignment of subjects to an intervention or control group, prospective follow-up, and Papanicolaou smear use or recommendation as an outcome. Pre-post designs without control groups were excluded because secular trends to increased Papanicolaou smear use in the past two decades^{3,4} would limit the interpretation of intervention effectiveness. Non-US studies were excluded because differences across systems of care might limit the generalizability of outcomes.

From the review of abstracts, 66 studies were potentially eligible for inclusion. Of this number, 14 were eliminated because they lacked concurrent or randomly assigned control groups and 27 were eliminated because the outcome was not receipt or recommendation of Papanicolaou smear and were non-US studies. Physician-targeted interventions with a documented outcome of recommendation of Papanicolaou smear use were not excluded because these interventions were designed to improve this behavior. Nine interventions were excluded because they were designed to improve follow-up after abnormal Papanicolaou smears, which left 16 studies as a result of the search.⁷⁸⁻⁹⁰ Because electronic searches might not identify all relevant studies,⁹¹ reference lists and published reviews of interventions^{70,75,76} were reviewed, and a hand search of the journals *Preventive Medicine* and *American Jour-*

*References 5,6,13,16,17,19,23,24,26,42,43,45,51,53-55.

†References 17,18,22,32,34,36,40,41,45,54,56,57.

‡References 5,6,8,14-16,18-20,22,23,40,41,49-51,54,58-63.

§References 5,7,13,16,38,40,42-44,51,59,65-69.

||References 7,11,12,40,42-44,65-67,69-71.

nal of Preventive Medicine for 1999 through April 2001 was conducted to find other eligible studies. Thirty additional studies were found,⁹²⁻¹²⁴ and 46 studies are included in this article.

Data Abstraction

Data were abstracted from studies using a standardized abstraction format to describe the intervention target (ie, patient, physician, patient and physician, or health care system), type of intervention, intervention content, means of determining receipt of Papanicolaou smear (eg, self-report, chart), characteristics of the patient population, and intervention effectiveness. In randomized trials where the sample size was not reported for each arm, the sample was divided by the number of study arms to estimate the number of women in each arm.

Each intervention within a study was abstracted separately. Within studies, interventions were classified based on the underlying mechanism of an intervention to increase Papanicolaou smear use using a previously developed classification scheme.¹²⁵ Interventions were classified as behavioral, cognitive, sociologic, or a combination of the three. Behavioral interventions change stimuli associated with Papanicolaou smear use (eg, reminders). Cognitive interventions provide new information, educate women about Papanicolaou smears, and clarify any existing misperceptions. Cognitive interventions were categorized further as individually tailored or based on theory (eg, health belief model) and as using generic educational materials. Cognitive interventions were also classified based on the method of delivery—interactively (eg, by telephone or in person) or statically (eg, by letter or pamphlet). Sociologic interventions use social norms or peers to increase Papanicolaou smear use (eg, lay health workers, peer counselors).

Interventions were classified further based on the content of the intervention (eg, telephone reminder) and type of control group to which the intervention was compared. Studies that included a lower level intervention to increase Papanicolaou smear use as the control group (eg, postcard reminder) were considered to have active controls. Studies in which the control group did not receive any specific strategies to increase Papanicolaou smear use were classified as having usual-care controls. In studies with combined interventions in which the same strategy was applied to intervention and control groups (active controls), the interven-

tion was categorized by the difference between intervention and control groups.

Data Analysis

Effect sizes and 95% confidence intervals (CI) were calculated for each intervention. For randomized studies, intervention effectiveness was calculated as the difference in Papanicolaou smear use between the intervention and control groups at the first assessment of intervention effectiveness. Variance was calculated for binomial proportions for intervention and control groups. For concurrently controlled studies, the effect size was calculated as the difference between the screening rates before and after the intervention for the intervention group and the control group ($[P_{\text{screened postintervention}} - P_{\text{screened preintervention}}] - [P_{\text{screened postcontrol}} - P_{\text{screened precontrol}}]$). Variance was calculated for the binomial proportions for intervention and control groups both before and after the intervention.

Compliance scores, which measured compliance with recommended screening frequency (number of screenings during a specified period divided by the number of women eligible for screening), were treated as the proportion of women screened for the purposes of this article. In two studies, compliance scores were based on a 3-year frequency of Papanicolaou smear use^{108,109} and were greater than 100% because most screening guidelines recommend screening more often than every 3 years. These scores were divided by 3 to create an average annual compliance score.

Within each group of intervention (eg, reminders mailed to patients compared with active controls), the effect size and 95% confidence interval for each intervention was graphed, and graphs were inspected visually for signs of heterogeneity. Because of the variability in patient populations and setting, as well as small numbers of interventions in any single category, we did not perform quantitative analysis.

Results

Of the 46 studies, there were 63 separate interventions; 24 were targeted to patients, 25 to physicians, and 12 to both patients and physicians. Two interventions introduced system changes (Table 1^{78-90,92-124}). Most studies were randomized controlled trials ($n = 31$; 67.4%). Overall, the largest number of interventions, 22, used behavioral strategies; all other categories had 10 or fewer interven-

Table 1. Study Characteristics.

Characteristics	No.	Percent	References
<i>Studies</i>	46	100.0	
Study design			
Randomized controlled trial*	31	67.4	78,83–89,93–95,97,98,101,102–104,106–109,111–113,116,118–121,123,124
Concurrently controlled	15	32.6	79,82,90,92,96,99,100,105,110,114,115,117,122
Type of control			
Usual care	30	65.2	78–84,87–89,92–100,102,107,109,110,112,114,115,117,122–124
Active control	16	34.8	85,86,90,101,103–106,108,111,113,116,118–121
<i>Interventions</i>	63	100.0	
Intervention target			
Patients	24	38.1	78,80–89,94,96,100,102,103,111–113,116,122
Physicians	25	39.7	85,86,90,92,93,95,97,101,104,107,108,111,114,115,118–121,124
Patients and physicians	12	19.0	79,85,98,99,106,109–111,116,121,123,124
System	2	3.2	105,117
Intervention strategy			
Behavioral	22	34.9	85,86,90,92,93,95–97,101,103,104,107,109,111,115,116,118–121,124
Cognitive	5	7.9	97,102,108,113,119
Sociologic	5	7.9	80,83,84,87,100
Behavioral and cognitive	10	15.9	85,94,97–99,106,110,112,114,121
Cognitive and sociologic	3	4.8	78,88,89
Behavioral, cognitive, and sociologic	5	7.9	79,81,82,122,123
Intervention content			
Behavioral strategy			
Postcard or letter reminder	16	25.4	79,85,86,94,103,106,111,112,116,123,124
Telephone reminder	2	3.2	103,86
Health diary	2	3.2	96,99
Chart reminder	22	34.9	85,86,95,98,106,107,108,109,110,111,114,115,116,118,119,121,123,124
Office reminders or poster display	3	4.8	79,99,110
Patient-carried prompt	4	6.3	98,106,109,120
Flow sheet or checklist requiring completion	9	14.3	90,92,93,97,104,106,108,110,116
Mass media reminders	1	1.6	81
Financial incentives	3	4.8	82,101,122
Cognitive strategy			
Educational letter or pamphlet	13	20.6	79,81,82,85,94,99,102,106,113,121,123
Telephone or in-person counseling	3	4.8	79,112,121
Educational mass media	2	3.2	78,79
Educational workshop or presentation	9	14.3	78,79,97,98,106,110,114,123
Audit with feedback	5	7.9	97,106,108,119
Sociologic strategy			
Peer or lay health workers	10	15.9	78,79,80,82,83,84,87,88,100,122
Culturally sensitive videotape	3	4.8	80,81,89
Outcome measurement			
Self-report	15	32.6	78–84,87,88,97,99,100,102,112,113
Chart audit	23	50.0	89,90,92–96,98,101,105–110,114,115,118,120–124
Claims or electronic record	10	21.7	83,85,86,103,104,111,116–119
Patient age-group			
<40 years	14	30.4	82,84–89,93,100,106,111,113,117,121
40–49 years	23	50.0	78,80,82–84,86–89,93,97,100,102,103,106,108,109,111–113,116,117,124
50–59 years	28	60.9	78,80,82–84,87–89,92,93,95–100,103,104,106–109,112,113,115–117,124
60+ years	19	41.3	79,80,84,87,89,93–95,97,98,100,103,104–106,112,113,117,120
Not stated	9	19.6	81,90,101,110,114,118,119,122,123
Patient race			
>20% African American	19	41.3	79,85,87,89,92,98,99,101,104–108,111,113,115,120,122,124
>20% Hispanic, Latina	6	13.0	80,84,89,96,98,106
>20% Asian, Pacific Islander	3	6.5	81,82,100
>20% Native American	2	4.3	88,117
>20% White	12	26.1	78,83,98,102,103,108,109,111,113,115,120,124
Not stated	14	30.4	86,90,93–95,97,110,112,114,116,118,119,121,123
Percentage with health insurance			
<50%	4	8.7	80,84,88,89
50–74%	4	8.7	81,98,111,113
75%+	16	34.8	78,82,83,85,86,92,94,99,101,103,105,106,108,109,112,116
Not stated	22	47.8	79,87,90,93,95–97,100,102,104,107,110,114,115,117–124

Table 1. Continued.

Characteristics	No.	Percent	References
Previous Papanicolaou smear use			
0–24%	3	6.5	78,103,121
25–49%	10	21.7	82–85,88,90,98,102,111,117
50–74%	6	13.0	79,81,87,92,106,114
75%+	1	2.2	78
Not stated	29	63.0	80,83,86,89,93–97,99–101,103,104,105,107–110,112,113,115,116,118–120,122–124
Time for assessment			
<3 months	1	2.2	90
3–6 months	12	26.1	84,89,94–96,99,102,104,114–116,121
6–12 months	13	28.3	86,93,103,105,108,111,117,119,120,122,124
12+ months	20	43.4	78–83,85,87,88,92,97,98,100,101,106,107,110,113,118,123
Not stated	1	2.2	112

*May add to more than 100%, because many interventions used multiple components.

tions each. Most studies included women in the 50- to 59-year age-group (60.9%), and approximately 30% of the studies included women younger than 40 years. Many studies (41.3%) included a sizable portion (>20%) of minority women. About one half of the studies reported health insurance status of the patient population. Among this group, most were conducted in samples where at least 75% of the patient population had health insurance. Finally, the period of assessment following intervention delivery was most frequently 12 or more months, although many studies also reported assessments of 3 to 6 and 6 to 12 months.

The types of interventions changed during the past two decades. In general, most interventions conducted in the 1980s and early 1990s were compared with usual-care controls, whereas those conducted in the 1990s were mainly compared with active controls. Additionally, interventions conducted in the late 1990s generally included multiple different components and targeted patients and providers, whereas those conducted in earlier years focused on single components and targeted patients or providers. For example, in an intervention published in 1999, Paskett and colleagues⁷⁹ reported the combined effectiveness of an intervention that targeted both patients and providers and used letter reminders, office reminders, multiple educational strategies, mass media, and lay health workers. Earlier interventions evaluated provider reminders alone.¹¹⁹

Patient-Targeted Interventions

The 24 patient-targeted interventions are listed in Table 2.¶

Behavioral Interventions

Compared with usual care, the single behavioral intervention was very effective and increased Papanicolaou smear use by 24.4% (95% CI: 11.1, 37.7).⁹⁶ Among the five interventions that were compared with active controls, one intervention was associated with decreased rates of Papanicolaou smear use (–8.6%; 95% CI: –13.1, –4.1).¹¹¹ Compared with active controls, the other four behavioral strategies were effective, and improvements in Papanicolaou smear use ranged from 10.1% to 18.8%.^{86,103,116} The telephone reminder was associated with the largest increase in Papanicolaou smear use and was from a single study in which multiple interventions were tested separately.⁸⁶

Cognitive Interventions

All four cognitive interventions were theory based and compared with active controls. The three delivered statically by letter did not improve Papanicolaou smear use, but the fourth, delivered interactively by telephone, led to an increase in Papanicolaou smear use of 8%, although this finding was not statistically significant (95% CI: –1.4, 17.4).¹¹³

Two of the three behavioral and cognitive interventions utilized mailed generic educational information and reminders and were not associated with significant improvements in Papanicolaou smear use.^{85,94} The third, which incorporated a telephone call from a health educator with the reminder in the intervention group, reported a 13.5% increase in Papanicolaou smear use (95% CI: 7.6,19.4).

¶References 78,80–89,94,96,100,102,103,111–113,116,122.

Table 2. Patient-Targeted Interventions to Increase Papanicolaou Smear Use.

Intervention	Author, Year	Intervention Content	Sample Size (No.)		Number (%) Screened		Effect Size	95% CI
			Intervention	Control	Intervention	Control		
Behavioral, usual-care controls	Dickey & Pettit, 1992 ^{96*}	Health diary reminder	142	73	111 (78.2)	39 (53.4)	24.4	11.1, 37.7
Behavioral, active controls	Ornstein et al, 1991 ¹¹¹	Letter reminder	1,054	843	394 (37.4)	388 (46.0)	-8.6	-13.1, -4.1
	Lantz et al, 1995 ¹⁰³	Letter, telephone reminders	236	238	45 (19.1)	14 (5.9)	13.2	7.4, 19.0
	Somkin et al, 1997 ¹¹⁶	Letter reminder	1,188	1,188	230 (19.4)	108 (9.1)	10.4	7.6, 13.2
	Binstock et al, 1997 ⁸⁶	Phone reminder	1,526	1,526	536 (35.1)	249 (16.3)	18.8	15.8, 21.8
	Binstock et al, 1997 ⁸⁶	Letter reminder	1,526	1,526	403 (26.4)	249 (16.3)	10.1	7.2, 13.0
Cognitive theory-based, active controls, static delivery	Kreuter & Strecher, 1996 ¹⁰²	Educational letter	48	32	30 (62.5)	21 (65.6)	-3.0	-24.4, 18.4
	Kreuter & Strecher, 1996 ¹⁰²	Educational letter	46	32	24 (52.2)	21 (65.6)	-14.0	-35.9, 7.9
	Rimer et al, 1999 ¹¹³	Educational letter	206	206	107 (52.0)	115 (56.0)	-4.0	-13.6, 5.6
Cognitive theory-based, active controls, interactive	Rimer et al, 1999 ¹¹³	Telephone counseling	206	206	132 (64.0)	115 (56.0)	8.0	-1.4, 17.4
	Clementz et al, 1990 ⁹⁴	Letter reminder, educational pamphlet	102	76	21 (20.6)	23 (30.3)	-9.7	-22.7, 3.3
Behavioral and cognitive (generic)	Reding et al, 1997 ¹¹²	Letter reminder, telephone education	233	240	45 (19.2)	14 (5.8)	13.5	7.6, 19.4
	Burack et al, 1998 ⁸⁵	Letter reminder, educational pamphlet	964	964	280 (29.0)	270 (28.0)	1.0	-3.0, 5.0
	Yancey et al, 1995 ⁸⁹	Culturally sensitive video	868	876	168 (19.4)	120 (13.7)	5.7	2.2, 9.2
Sociologic	Suarez et al, 1997 ⁸⁰	Lay health worker, culturally sensitive video	Pre: 450 Post: 450	Pre: 473 Post: 473	Pre: 205 (45.6) Post: 231 (51.3)	Pre: 237 (50.1) Post: 268 (56.7)	-0.7	-9.8, 8.4
	Sung et al, 1997 ⁸⁷	Lay health worker	163	158	96 (58.7)	98 (62.1)	-3.4	-14.1, 7.3
	Margolis et al, 1998 ⁸³	Lay health worker	501	466	352 (70.3)	293 (62.9)	7.4	1.5, 13.3
	Navarro et al, 1998 ⁸⁴	Lay health worker	199	162	130 (65.3)	99 (61.1)	4.2	-5.8, 14.2
	Gotay et al, 2000 ¹⁰⁰	Lay health worker	Pre: 318 Post: 318	Pre: 360 Post: 360	Pre: 188 (59.0) Post: 213 (67.0)	Pre: 277 (63.0) Post: 232 (64.0)	7.0	-3.3, 17.3
	Dignan et al, 1996 ⁸⁸	Lay health worker	385	430	282 (73.2)	275 (64.0)	9.2	2.9, 15.5
	Allen et al, 2001 ⁷⁸	Lay health worker, mass media, workshop	1,374	1,288	1,116 (81.2)	1,011 (78.5)	2.7	-0.3, 5.7
	Whitman et al, 1994 ¹²²	Lay health worker, financial incentives, workshop	Pre: 284 Post: 283	Pre: 189 Post: 175	Pre: 34 (12.0) Post: 74 (26.0)	Pre: 74 (39.0) Post: 30 (17.0)	36.0	25.1, 46.9
Sociologic, behavioral, and cognitive, usual-care controls	Bird et al, 1998 ⁸²	Lay health worker, financial incentives, educational pamphlet	Pre: 306 Post: 346	Pre: 339 Post: 372	Pre: 141 (46.1) Post: 228 (65.9)	Pre: 136 (40.1) Post: 156 (41.9)	18.0	7.6, 28.4
	Jenkins et al, 1999 ⁸¹	Educational pamphlet, mass media, culturally sensitive video	Pre: 451 Post: 454	Pre: 482 Post: 422	Pre: 245 (54.4) Post: 217 (47.7)	Pre: 210 (43.6) Post: 156 (37.0)	-0.1	-9.9, 8.3

CI = confidence interval.

*Based on the Papanicolaou smear being recommended or completed.

Sociologic Interventions

Most of the sociologic interventions were targeted to specific ethnic groups and used lay health workers,¹²⁶ women recruited from the target population, to encourage women to attend screening.^{80,82–84,87} The interventions that used sociologic strategies alone and sociologic and cognitive strategies had similar effects, and most improved Papanicolaou smear use from 2.7% to 9.2%,^{78,82–84,88,89,100,122} although not all increases were statistically significant. Two interventions were associated with decreased Papanicolaou smear use,^{80,87} although this finding was not statistically significant. The authors of one of these interventions speculated that increased outreach efforts in the comparison community were responsible for a lack of effect.⁸⁰ Two of the three sociologic, behavioral, and cognitive interventions led to large increases in Papanicolaou smear use, 18.0% and 36.0%.^{82,122} The first, conducted by Bird and colleagues,⁸² used lay health workers, educational pamphlets, and financial incentives and was culturally specific to Vietnamese-American women. The apparent effectiveness of the second, conducted by Whitman and colleagues,¹²² might be due to the decline in Papanicolaou smear use from 39% to 17% in the concurrent control group. The other intervention in this category relied on media to present role model behaviors and did not lead to increased Papanicolaou smear use.⁸¹

Provider-Targeted and Provider- and Patient-Targeted Interventions

The 27 provider targeted interventions are listed in Table 3,** and the 12 provider- and patient-targeted interventions are listed in Table 4.††

Behavioral Interventions

The nine interventions compared with usual-care controls‡‡ did not appear to have higher rates of screening than similar interventions compared with active controls§§ (Table 3). There was great heterogeneity among the behavioral interventions, ranging from a statistically significant 18% de-

crease in Papanicolaou smear use⁹³ to a 44% increase.⁹⁰ There was no clear difference in effectiveness between chart reminders and flow sheets requiring completion; in fact, both studies with extreme findings used flow sheets requiring completion. In the study with decreased Papanicolaou smear use, the authors suggested that the intervention was incompletely implemented, leading to an unexpected decline in Papanicolaou smear use. The same intervention, however, was also assessed for other preventive strategies and was associated with increased clinical breast examination, mammography, and three types of immunizations.⁹³ The intervention associated with a 44% increase in Papanicolaou smear use was based on a potentially inappropriate concurrent control group—preintervention rates of Papanicolaou smear use were 98% in the control group compared with 43% in intervention arm.⁹²

Provider- and patient-targeted behavioral interventions were also heterogeneous and ranged in effectiveness from a 6% decrease (95% CI: -10.5, -1.5)¹¹¹ to 13.8% increase (95% CI: 10.9, 16.7) in Papanicolaou smear use¹¹⁶ (Table 4).

Cognitive Interventions

The three interventions that used seminars or audit with feedback^{97,108,119} led to slight increases in Papanicolaou smear use, from 2%⁹⁷ to 8%.¹⁰⁸ Three interventions used a combination of cognitive and behavioral strategies.^{97,114,119} The effects were varied and ranged from a significant decline in Papanicolaou smear use of -6% (95% CI: -11.9, -0.1)¹¹⁹ to an 18% increase (95% CI: -21.3, 57.3)¹¹⁴ (Table 3).

Interventions targeted to patients and physicians using behavioral and cognitive strategies were also variable in their impact on Papanicolaou smear use, ranging from a 7% decrease in use (95% CI: -10.6, -3.4)⁹⁸ to a 13% increase in Papanicolaou smear use (95% CI: -7.5, 32.5).¹²¹ Although most estimates were positive, only one, which included six separate intervention components, was statistically significant¹⁰⁶ (Table 4).

Sociologic Interventions

The combined sociologic, behavioral, and cognitive intervention strategy targeted to physicians and patients that used a generic educational strategy had little impact on Papanicolaou smear use,¹²³ whereas the intervention that used church liaisons,

**References 85,86,90,92,93,95,97,101,104,107,108,111, 114,115,118–121,124.

††References 79,85,98,99,106,109–111,116,121,123,124.

‡‡References 92,93,95,97,107,108,115,119,124.

§§References 85,86,90,101,104,111,118,120,121.

Table 3. Provider-Targeted Interventions to Increase Papanicolaou Smear Use.

Intervention	Author, Year	Content Intervention	Sample Size		Number (%) Screened		Effect Size	95% CI
			Intervention	Control	Intervention	Control		
Behavioral, usual-care control	McDonald et al, 1984 ^{107*}	Computerized reminder	NA	NA	(38.0)	(23.0)	15.0	NA
	Tierney et al, 1986 ¹¹⁹	Computerized reminder	409	409	106 (26.0)	115 (28.0)	-2.0	-8.1, 4.1
	Cheney & Ramsdell, 1987 ⁹³	Flow sheet w/completion	132	132	75 (57.0) [†]	99 (75.0) [†]	-18.0	-29.2, -6.8
	Becker et al, 1989 ¹²⁴	Chart reminder	146	123	9 (6.2)	7 (5.7)	0.5	-5.2, 6.1
	Cowan et al, 1992 ^{95*}	Chart reminder	32	23	4 (12.5)	1 (4.3)	8.2	-5.9, 22.3
	Dietrich et al, 1992 ^{97*}	Flow sheet w/completion	NA	NA	(71.0)	(61.0)	10.0	NA
	Cardozo et al, 1998 ⁹²	Flow sheet w/completion	Pre: 82 Post: 74	Pre: 94 Post: 82	Pre: 35 (43.0) Post: 58 (79.0)	Pre: 92 (98.0) Post: 74 (90.0)	44.0	28.2, 59.8
	Schreiner et al, 1988 ^{115*}	Chart reminder	NA	NA	Pre: (25.0) Post: (34.0)	Pre: (28.0) Post: (31.0)	6.0	NA
	Gonzalez et al, 1989 ^{90*}	Flow sheet w/completion	Pre: 52 Post: 52	Pre: 47 Post: 47	Pre: 21 (40.0) Post: 34 (65.0)	Pre: 14 (30.0) Post: 15 (32.0)	23.0	-3.4, 49.4
	McPhee et al, 1989 ^{108†}	Computerized reminder	432	432	245 (56.7) [†]	199 (46.0) [†]	10.7	4.1, 17.3
Behavioral, active control	Turner et al, 1989 ¹²¹	Computerized reminder	42	42	14 (33.1)	12 (27.5)	5.6	-14.0, 25.2
	Turner et al, 1990 ^{120*}	Patient carried prompt	94	151	28 (29.8)	30 (19.9)	10.0	-1.2, 21.2
	Ornstein et al, 1991 ¹¹¹	Computerized reminder	1,111	843	487 (43.8)	388 (46.0)	-2.2	-6.7, 3.3
	Litzelman et al, 1993 ¹⁰⁴	Flow sheet w/completion	1,460	1,459	307 (21.0)	263 (18.0)	3.0	0.1, 5.9
	Tape & Campbell, 1993 ^{118*}	Computerized reminder	462	443	114 (24.7)	106 (23.9)	0.8	-4.8, 6.4
	Binstock et al, 1997 ⁸⁶	Memo reminder	1,526	1,526	389 (25.5)	249 (16.3)	9.2	6.3, 12.1
	Binstock et al, 1997 ⁸⁶	Computerized reminder	1,526	1,526	365 (23.9)	249 (16.3)	7.6	4.8, 10.4
	Burack et al, 1998 ⁸⁵	Computerized reminder	960	964	278 (29.0)	270 (28.0)	1.0	-3.0, 5.0
	Hillman et al, 1998 ^{101*}	Financial incentives	NA	NA	(42.7)	(33.1)	9.6	NA
	Tierney et al, 1986 ¹¹⁹	Audit with feedback	409	409	131 (32.0)	115 (28.0)	4.0	-2.3, 10.3
Cognitive, usual-care controls	McPhee et al, 1989 ^{108†}	Audit with feedback	432	432	233 (54.0) [†]	199 (46.0) [†]	8.0	1.4, 14.6
	Dietrich et al, 1992 ^{97*}	Workshop, audit with feedback	NA	NA	(63.0)	(61.0)	2.0	NA
	Tierney et al, 1986 ¹¹⁹	Audit with feedback, computerized reminder	409	409	90 (22.0)	115 (28.0)	-6.0	-11.9, -0.1
Behavioral and cognitive, usual-care controls	Robie, 1988 ¹¹⁴	Workshop, chart reminder	Pre: 13 Post: 20	Pre: 28 Post: 32	Pre: 4 (31.0) Post: 10 (50.0)	Pre: 6 (21.0) Post: 7 (22.0)	18.0	-21.3, 57.3
	Dietrich et al, 1992 ^{97*}	Workshop, audit with feedback, flow sheet w/completion	NA	NA	(65.0)	(61.0)	4.0	NA
	Tierney et al, 1986 ¹¹⁹	Audit with feedback, computerized reminder	409	409	90 (22.0)	115 (28.0)	-6.0	-11.9, -0.1

NA = not available.

*Based on the Papanicolaou smear being recommended or completed.

†Represents compliance scores.

‡Three-year rates of Papanicolaou smear use converted to annual rates.

Table 4. Patient- and Provider-Targeted Interventions to Increase Papanicolaou Smear Use.

Intervention	Author, Year	Intervention Content	Sample Size		Number (%) Screened		Effect Size	95% CI
			Intervention	Control	Intervention	Control		
Behavioral, usual-care control	Becker et al, 1989 ¹²⁴	Chart reminder, reminder letter	114	123	14 (12.3)	7 (5.7)	6.6	-0.7, 13.9
	McPhee et al, 1991 ^{109*}	Computerized reminder, patient-carried prompt	710	710	366 (51.6) [†]	286 (40.3) [†]	11.3	6.1, 16.5
	Ornstein et al, 1991 ¹¹¹	Computerized reminder, reminder letter	1,006	843	402 (40.0)	387 (46.0)	-6.0	-10.5, -1.5
Behavioral and cognitive, usual-care controls	Somkin et al, 1997 ¹¹⁶	Reminder letter, reminder with completion	1,188	1,188	271 (22.8)	108 (9.1)	13.8	10.9, 16.7
	Gemson et al, 1995 ^{99‡}	Educational pamphlet, health diary, office reminder	Pre: 38 Post: 71	Pre: 35 Post: 53	Pre: NA Post: NA	Pre: NA Post: NA	6.0	NA
	Dietrich et al, 1998 ^{98‡}	Chart reminder, educational workshop, patient-carried prompt	1,059	918	585 (55.2)	572 (62.2)	-7.0	-10.6, -3.4
Behavioral and cognitive, active controls	Melnikow et al, 2000 ¹¹⁰	Computerized reminder, reminder with completion, educational workshop, office reminder	Pre: 295 Post: 295	Pre: 310 Post: 310	Pre: 136 (46.0) Post: 139 (47.0)	Pre: 205 (66.0) Post: 198 (64.0)	3.0	-8.0, 14.0
	Turner et al, 1989 ¹²¹	Computerized reminder, educational pamphlet	42	42	17 (40.0)	12 (27.5)	12.5	-7.5, 32.5
	Burack et al, 1998 ⁸⁵	Letter reminder, educational pamphlet, computerized reminder	960	964	307 (32.0)	270 (28.0)	4.0	-0.1, 8.1
Behavioral, cognitive (generic), and sociologic	Manfredi et al, 1998 ¹⁰⁶	Reminder with completion, audit with feedback, patient-carried prompt, educational workshop	821	647	429 (52.3)	269 (41.6)	10.0	4.9, 15.1
	Williams et al, 1998 ¹²³	Reminder letter, educational pamphlet, computerized reminder, educational workshop	725	725	159 (21.9)	183 (25.2)	-3.3	-7.7, 1.1
Behavioral, theory-based cognitive and sociologic	Paskett et al, 1999 ⁷⁹	Reminder letter, health diary, chart reminders, educational mass media, educational pamphlet, educational counseling, lay health worker, educational workshop	Pre: 125 Post: 168	Pre: 123 Post: 134	Pre: 91 (73.0) Post: 146 (87.0)	Pre: 82 (67.0) Post: 80 (60.0)	21.0	6.0, 36.0

NA = not available.

*Three-year rates of Papanicolaou smear use converted to annual rates of Papanicolaou smear use.

[†]Represents compliance scores.

[‡]Based on Papanicolaou being recommended or completed.

educational mass media campaigns, lay health workers, theory-based education, and community activities as the cognitive strategies^{79,127} led to a 21% increase in Papanicolaou smear use (95% CI: 6.0, 36.0) (Table 4).

System Interventions

Finally, two interventions introduced system changes.^{105,117} One altered how medical care was delivered by integrating into a clinic a nurse-practitioner who was able to perform same-day screening.¹⁰⁵ This intervention was extremely effective, leading to a 32.7% increase in Papanicolaou smear use (95% CI: 20.5, 44.9). The other system intervention used trained community health workers and led to a 7% increase in Papanicolaou smear use (95% CI: -1.3, 15.3), although it was not statistically significant.

Discussion

As shown in this systematic review of interventions to increase Papanicolaou smear use, many patient and provider barriers can be overcome with well-implemented interventions. Selection and implementation of intervention strategies to improve Papanicolaou smear screening can be based, in part, on the characteristics of the underlying patient and provider populations. For example, patient forgetfulness can be overcome with behavioral reminders sent to the home or delivered by telephone. Telephone reminders increased Papanicolaou smear use by up to 18% (95% CI: 15.8, 21.8).⁸⁶ Such reminder interventions might be particularly effective in increasing regular screening among women who previously had a Papanicolaou smear. Forgetfulness in providers can also be overcome with behavioral reminders included on the chart or flow sheets requiring completion, although these findings varied widely.

Women who have not had a previous Papanicolaou smear might be difficult to reach through traditional medical settings and might require more extensive outreach strategies. Sociologic strategies, which use lay health workers, could be effective in populations who might distrust the health care system or have other cultural barriers to screening. Sociologic strategies were marginally effective in increasing Papanicolaou smear use, although a culturally sensitive intervention that also included behavioral and cognitive strategies was particularly

effective in a population of Vietnamese-American women, increasing Papanicolaou smear use by 18.0% (95% CI: 7.6, 28.4).⁸²

Few interventions focused on patient lack of knowledge or fears of Papanicolaou smear, although use of interactive delivery of cognitive educational interventions by telephone was associated with increased Papanicolaou smear use. Provider educational strategies developed to clarify information about screening efficacy and guidelines or to improve proficiency were marginally effective in increasing Papanicolaou smear use. Interventions that targeted both patients and providers appeared to increase screening, although they were generally not much more effective than similar interventions targeted to either patients or providers alone.

Few interventions introduced system level changes, although one that integrated a nurse practitioner into a primary care practice who could also perform same-day screening led to a large increase in Papanicolaou smear use (32.7%; 95% CI: 20.5, 44.9).¹⁰⁵ Other uncontrolled strategies that use same-day screening in emergency departments^{128,129} or churches¹³⁰ have been reported to be feasible and to increase Papanicolaou smear use. These opportunistic screening strategies might also be more resource intensive and require reservation of personnel and facilities for performance of screening on demand. Other effective strategies, such as patient or provider reminders, could be inexpensive on an on-going basis, but might require an initial investment in computer infrastructure. Thus, measuring the cost and cost-effectiveness of different intervention strategies will provide important information for health departments, providers, and other health care organizations about the feasibility of implementing interventions to improve Papanicolaou use.^{38,131}

In several cases, interventions were ineffective in increasing Papanicolaou smear use, but the same intervention in the same provider and patient populations led to large increases in mammography or other preventive services.^{93,119} There are several potential alternative explanations for this finding, including differences in a woman's perception of these tests or likelihood of developing cancer, differences in provider beliefs about proficiency, or the time required for performance of different screening tests. Exploring potential differences in intervention effectiveness and any differential impact of the underlying barriers for screening in

different types of screening tests will be an important area for future cancer control research.

There are some limitations with this review, including the reliance on an electronic search of the published literature for identifying interventions, the combination of multiple measures of Papanicolaou smear utilization (eg, self-report, chart review) or documented Papanicolaou smear ordering, and discrepancies between the unit of randomization and the unit of analysis in published interventions. Our search strategy, although similar to one used successfully for meta-analyses of interventions to increase mammography use,^{132,133} found fewer interventions than did the review of bibliographies or the hand search of recent articles published in prevention-oriented journals. Additionally, studies with negative findings might be less likely to be published⁹¹ and found by our search strategy. As a result, the estimates of intervention effectiveness presented here might overstate their true effectiveness.

Studies included here used different mechanisms to determine Papanicolaou smear use, including self-report, chart-audit, and electronic claims. Papanicolaou smear self-report has been reported to overestimate utilization when compared with charts or claims data, with reports of accuracy ranging from 67% to 99% agreement.^{134–138} Similarly, the timing of the measurement of Papanicolaou smear receipt differed across the studies, with some studies reporting Papanicolaou smear use within 6 months of the intervention¹³⁹ and others reporting Papanicolaou smear use 1 year or more 2 years or more after the intervention was initiated.¹⁴⁰ Additionally, some of the provider-targeted interventions were based on whether Papanicolaou smears were recommended or ordered,^{95,99,101,107,118} rather than on a woman's receipt of Papanicolaou smear. Within a given study, however, women in the intervention and control arms should be equally likely to overstate utilization or not comply with provider recommended Papanicolaou smear, so the relative estimate (intervention-control) is unlikely to be affected. In two studies, Papanicolaou smear use was measured as a 3-year compliance rate and converted to an annual rate because compliance was greater than 100%.^{108,109} These annual rates

might understate the effectiveness of these interventions.

Several studies randomized clinics, physician practices, churches, or more broadly defined communities to intervention and control conditions and then performed analysis on the number of women in each of the groups, rather than the unit of randomization.^{92,111} Women living within a specific community or treated at a similar clinic are more likely to have similar behaviors and are not independent observations.¹³⁹ If the actual unit of randomization or the correlation among women was accounted for in analysis, the point estimate of intervention effectiveness would not be affected, but the confidence interval would likely be wider. As a result, the confidence intervals reported here could overestimate the effectiveness of interventions to increase Papanicolaou smear use.

References

1. Clarke EA, Anderson TW. Does screening by "Pap" smears help prevent cervical cancer? A case-control study. *Lancet* 1979;2:1–4.
2. La Vecchia C, Franceschi S, Decarti A, Fasoli M, Gentile A, Tognoni G. "Pap" smear and the risk of cervical neoplasia: quantitative estimates from a case-control study. *Lancet* 1984;2:779–82.
3. Blackman DK, Bennett EM, Miller DS. Trends in self-reported use of mammograms (1989–1997) and Papanicolaou tests (1991–1997)—Behavioral Risk Factor Surveillance System. *Morbidity and Mortality Weekly Report* 1999;48:1–22.
4. Breen N, Wagener DK, Brown ML, Davis WW, Ballard-Barbash R. Progress in cancer screening over a decade: results of cancer screening from the 1987, 1992 and 1998 National Health Interview Surveys. *J Natl Cancer Inst* 2001;93:1704–13.
5. Breast and cervical cancer screening among underserved women. Baseline survey results from six states. The National Cancer Institute Cancer Screening Consortium for Underserved Women. *Arch Fam Med* 1995;4:617–24.
6. Hayward RA, Shapiro MF, Freeman HE, Corey CR. Who gets screened for cervical and breast cancer? Results from a new national survey. *Arch Intern Med* 1988;148:1177–81.
7. Skaer TL, Robison LM, Selar DA, Harding GH. Knowledge, attitudes, and patterns of cancer screening: a self-report among foreign born Hispanic women utilizing rural migrant health clinics. *J Rural Health* 1996;12:169–77.
8. Calle EE, Flanders WD, Thun MJ, Martin LM. Demographic predictors of mammography and Pap smear screening in US women. *Am J Public Health* 1993;83:53–60.

||||References 84,89,94–96,102,104,114–116.

¶¶References 78–82,88,98,100,106,107,113.

9. Celentano DD, Klassen AC, Weisman CS, Rosen-shein NB. Cervical cancer screening practices among older women: results from the Maryland Cervical Cancer Case-Control Study. *J Clin Epidemiol* 1988;41:531-41.
10. Anderson LM, May DS. Has the use of cervical, breast, and colorectal cancer screening increased in the United States? *Am J Public Health* 1995;85: 840-2.
11. Elnicki DM, Morris DK, Shockcor WT. Patient-perceived barriers to preventive health care among indigent, rural Appalachian patients. *Arch Intern Med* 1995;155:421-4.
12. Mandelblatt J, Traxler M, Lakin P, Kanetsky P, Kao R. Mammography and Papanicolaou smear use by elderly poor black women. The Harlem Study Team. *J Am Geriatr Soc* 1992;40:1001-7.
13. Mamon JA, Shediac MC, Crosby CB, Sanders B, Matanoski GM, Celentano DD. Inner-city women at risk for cervical cancer: behavioral and utilization factors related to inadequate screening. *Prev Med* 1990;19:363-76.
14. Howe HL, Bzduch H. A survey of Pap smear screening in upstate New York. *NY State J Med* 1986;86:291-6.
15. Wilcox LS, Mosher WD. Factors associated with obtaining health screening among women of reproductive age. *Public Health Rep* 1993;108:76-86.
16. Ramirez AG, Suarez L, Laufman L, Barroso C, Chalela P. Hispanic women's breast and cervical cancer knowledge, attitudes, and screening behaviors. *Am J Health Promot* 2000;14:292-300.
17. Austin RM, Baron PL, Gates CE. Opportunities for enhanced cervical and breast screening referral in Charleston County. *J S C Med Assoc* 1993;89: 323-8.
18. Spurlock C, Nadel M, McManmon E. Age and Pap smear history as a basis for intervention strategy. *J Community Health* 1992;17:97-107.
19. Potosky AL, Breen N, Graubard BI, Parsons PE. The association between health care coverage and the use of cancer screening tests. Results from the 1992 National Health Interview Survey. *Med Care* 1998;36:257-70.
20. Gilliland FD, Mahler R, Hunt WC, Davis SM. Preventive health care among rural American Indians in New Mexico. *Prev Med* 1999;28:194-202.
21. Lengerich EJ, Conlisk EA, Pisano E, Harris L, Holliday J. A program to control breast and cervical cancer in North Carolina. *N C Med J* 1998;59: 110-4.
22. McPhee SJ, Bird JA, Davis T, Ha NT, Jenkins CN, Le B. Barriers to breast and cervical cancer screening among Vietnamese-American women. *Am J Prev Med* 1997;13:205-13.
23. Suarez L, Pulley L. Comparing acculturation scales and their relationship to cancer screening among older Mexican-American women. *J Natl Cancer Inst Monogr* 1995;18:41-7.
24. Norman SA, Talbott EO, Kuller LH, Krampe BR, Stolley PD. Demographic, psychosocial, and medical correlates of Pap testing: a literature review. *Am J Prev Med* 1991;7:219-26.
25. Sawyer JA, Earp J, Fletcher RH, Daye FF, Wynn TM. Pap tests of rural black women. *J Gen Intern Med* 1990;5:115-9.
26. Ayanian JZ, Kohler BA, Abe T, Epstein AM. The relation between health insurance coverage and clinical outcomes among women with breast cancer. *N Engl J Med* 1993;329:326-31.
27. Ries LAG, Eisner MP, Kosary CL, et al, editors. SEER cancer statistics review, 1973-1999. Bethesda, Md: National Cancer Institute, 2000. Available at http://seer.cancer.gov/csr/1973_1999/2002.
28. Mitchell JB, McCormack LA. Time trends in late-stage diagnosis of cervical cancer. Differences by race/ethnicity and income. *Med Care* 1997;35: 1220-4.
29. Breen N, Figueroa JB. Stage of breast and cervical cancer diagnosis in disadvantaged neighborhoods: a prevention policy perspective. *Am J Prev Med* 1996;12:319-26.
30. Healthy people 2010: understanding and improving health. 2nd ed. Washington, DC: US Department of Health and Human Services, 2000.
31. Schapira DV, Pamies RJ, Kumar NB, et al. Cancer screening. Knowledge, recommendations, and practices of physicians. *Cancer* 1993;71:839-43.
32. Grady KE, Lemkau JP, McVay JM, Reisine ST. The importance of physician encouragement in breast cancer screening of older women. *Prev Med* 1992;21:766-80.
33. Fox SA, Stein JA. The effect of physician-patient communication on mammography utilization by different ethnic groups. *Med Care* 1991;29:1065-82.
34. Fox SA, Siu AL, Stein JA. The importance of physician communication on breast cancer screening of older women. *Arch Intern Med* 1994;154:2058-68.
35. Mann LC, Hawes DR, Ghods M, Bednar EJ, Potchen EJ. Utilization of screening mammography: comparison of different physician specialties. *Radiology* 1987;164:121-2.
36. Vernon SW, Laville EA, Jackson GL. Participation in breast screening programs: a review. *Soc Sci Med* 1990;30:1107-18.
37. Bastani R, Marcus AC, Hollatz-Brown A. Screening mammography rates and barriers to use: a Los Angeles County survey. *Prev Med* 1991;20:350-63.
38. Lantz PM, Stencil D, Lippert MT, Jaros L, Eaker ED. Implementation issues and cost associated with a proven strategy for increasing breast and cervical cancer screening among low-income women. *J Public Health Manag Pract* 1996;2:54-9.

39. Lerman C, Caputo C, Brody D. Factors associated with inadequate cervical cancer screening among lower income primary care patients. *J Am Board Fam Pract* 1990;3:151-6.
40. Harlan LC, Bernstein AB, Kessler LG. Cervical cancer screening: who is not screened and why? *Am J Public Health* 1991;81:885-90.
41. Mandelblatt J, Traxler M, Lakin P, Kanetsky P, Kao R. Mammography and Papanicolaou smear use by elderly poor black women. The Harlem Study Team. *J Am Geriatr Soc* 1992;40:1001-7.
42. Walker R, Lucas W, Crespo R. The West Virginia Rural Cancer Prevention project. *Cancer Pract* 1994;2:421-6.
43. Frank-Stromborg M, Wassner LJ, Nelson M, Chilton B, Wholeben BE. A study of rural Latino women seeking cancer-detection examinations. *J Cancer Educ* 1998;13:231-41.
44. Perez-Stable EJ, Otero-Sabogal R, Sabogal F, McPhee SJ, Hiatt RA. Self-reported use of cancer screening tests among Latinos and Anglos in a pre-paid health plan. *Arch Intern Med* 1994;154:1073-81.
45. Lantz PM, Weigers ME, House JS. Education and income differentials in breast and cervical cancer screening. Policy implications for rural women. *Med Care* 1997;35:219-36.
46. McPhee SJ, Richard RJ, Solkowitz SN. Performance of cancer screening in a university general internal medicine practice: comparison with the 1980 American Cancer Society Guidelines. *J Gen Intern Med* 1986;1:275-81.
47. Herman CJ, Lengerich EJ, Stoodt G. Variation in recommendations for breast and cervical cancer screening among primary care physicians in North Carolina, 1991. *South Med J* 1996;89:583-90.
48. Rubin E, Frank MS, Stanley RJ, Bernreuter WK, Han SY. Patient-initiated mobile mammography: analysis of the patients and the problems. *South Med J* 1990;83:178-84.
49. Ives DG, Lave JR, Traven ND, Schulz R, Kuller LH. Mammography and Pap smear use by older rural women. *Public Health Rep* 1996;111:244-50.
50. Weinrich S, Coker AL, Weinrich M, Eleazer GP, Greene FL. Predictors of Pap smear screening in socioeconomically disadvantaged elderly women. *J Am Geriatr Soc* 1995;43:267-70.
51. Rimer BK, Conaway MR, Lyna PR, et al. Cancer screening practices among women in a community health center population. *Am J Prev Med* 1996;12:351-7.
52. Buller D, Modiano MR, Guernsey de Zapien J, Meister J, Saltzman S, Hunsaker F. Predictors of cervical cancer screening in Mexican American women of reproductive age. *J Health Care Poor Underserved* 1998;9:76-94.
53. Ornstein SM, Garr DR, Jenkins RG, Rust PF, Zemp L, Arnon A. Compliance with five health promotion recommendations in a university-based family practice. *J Fam Pract* 1989;29:163-8.
54. Kirkman-Liff B, Kronenfeld JJ. Access to cancer screening services for women. *Am J Public Health* 1992;82:733-5.
55. Katz SJ, Hofer TP. Socioeconomic disparities in preventive care persists despite universal coverage. Breast and cervical cancer screening in Ontario and the United States. *JAMA* 1994;272:530-4.
56. O'Malley AS, Mandelblatt J, Gold K, Cagney KA, Kerner J. Continuity of care and the use of breast and cervical cancer screening services in a multi-ethnic community. *Arch Intern Med* 1997;157:1462-70.
57. Polednak AP. Reported Pap test use by Hispanic women in Connecticut and Long Island. *Conn Med* 1996;60:3-8.
58. Skaer TL, Robison LM, Sclar DA, Harding GH. Cancer-screening determinants among Hispanic women using migrant health clinics. *J Health Care Poor Underserved* 1996;7:338-54.
59. Thomas SM, Fick AC. Women's health: early detection and screening practices for breast and cervical cancer. *J La State Med Soc* 1994;146:152-8.
60. Rutledge DN, Hartmann WH, Kinman PO, Winfield AC. Exploration of factors affecting mammography behaviors. *Prev Med* 1988;17:412-22.
61. Vincent AL, Greene JN, Hoercherl S, McTague D. Women at risk: Papanicolaou smear screening in Florida. *J Fla Med Assoc* 1997;84:302-7.
62. Stearns SC, Slifkin RT, Edin HM. Access to care for rural Medicare beneficiaries. *J Rural Health* 2000;16:31-42.
63. Hoffman-Goetz L, Breen NL, Meissner H. The impact of social class on the use of cancer screening within three racial/ethnic groups in the United States. *Ethn Dis* 1998;8:43-51.
64. Suarez L. Pap smear and mammogram screening in Mexican-American women: the effects of acculturation. *Am J Public Health* 1994;84:742-6.
65. Suarez L, Roche RA, Nichols D, Simpson DM. Knowledge, behavior, and fears concerning breast and cervical cancer among older low-income Mexican-American women. *Am J Prev Med* 1997;13:137-42.
66. Goldsmith DF, Sisneros GC. Cancer prevention strategies among California farm workers: preliminary findings. *J Rural Health* 1996;12(4 Suppl):343-8.
67. Dignan M, Michielutte R, Sharp P, Bahnson J, Young L, Beal P. The role of focus groups in health education for cervical cancer among minority women. *J Community Health* 1990;15:369-75.
68. Strickland J, Strickland DL. Barriers to preventive health services for minority households in the rural south. *J Rural Health* 1996;12:206-17.
69. Branoff R, Santi K, Campbell JK, Roetzheim R, Oler M. A family practice residency cervical screen-

- ing project: perceived screening barriers. *Fam Med* 1997;29:119–23.
70. Vellozzi CJ, Romans M, Rothenberg RB. Delivering breast and cervical cancer screening services to underserved women: Part I. Literature review and telephone survey. *Womens Health Issues* 1996;6:65–73.
 71. Perez-Stable EJ, Sabogal F, Otero-Sabogal R, Hiatt RA, McPhee SJ. Misconceptions about cancer among Latinos and Anglos. *JAMA* 1992;268:3219–23.
 72. Kraut AM. Healers and strangers. Immigrant attitudes toward the physician in America—a relationship in historical perspective. *JAMA* 1990;263:1807–11.
 73. Tosomeen AH, Marquez MA, Panser LA, Kottke TE. Developing preventive health programs for recent immigrants. A case study of cancer screening for Vietnamese women in Olmsted County, Minnesota. *Minn Med* 1996;79:46–8.
 74. Penn NE, Kar S, Kramer J, Skinner J, Zambrana RE. Ethnic minorities, health care systems, and behavior. *Health Psychol* 1995;14:641–6.
 75. Meissner HI, Breen N, Coyne C, Legler JM, Green DT, Edwards BK. Breast and cervical cancer screening interventions: an assessment of the literature. *Cancer Epidemiol Biomarkers Prev* 1998;7:951–61.
 76. Marcus AC, Crane LA. A review of cervical cancer screening intervention research: implications for public health programs and future research. *Prev Med* 1998;27:13–31.
 77. Cervical cancer screening. The Pap smear. Summary of an NIH consensus statement. *Br Med J* 1980;281:1264–6.
 78. Allen JD, Stoddard AM, Mays J, Sorensen G. Promoting breast and cervical cancer screening at the workplace: results from the Woman to Woman Study. *Am J Public Health* 2001;91:584–90.
 79. Paskett ED, Tatum CM, D'Agostino R, et al. Community-based interventions to improve breast and cervical cancer screening: results of the Forsyth County Cancer Screening (FoCaS) Project. *Cancer Epidemiol Biomarkers Prev* 1999;8:453–9.
 80. Suarez L, Roche RA, Pulley L, Weiss NS, Goldman D, Simpson DM. Why a peer intervention program for Mexican-American women failed to modify the secular trend in cancer screening. *Am J Prev Med* 1997;13:411–7.
 81. Jenkins CN, McPhee SJ, Bird JA, et al. Effect of a media-led education campaign on breast and cervical cancer screening among Vietnamese-American women. *Prev Med* 1999;28:395–406.
 82. Bird JA, McPhee SJ, Ha NT, Le B, Davis T, Jenkins CN. Opening pathways to cancer screening for Vietnamese-American women: lay health workers hold a key. *Prev Med* 1998;27:821–9.
 83. Margolis KL, Lurie N, McGovern PG, Tyrrell M, Slater JS. Increasing breast and cervical cancer screening in low-income women. *J Gen Intern Med* 1998;13:515–21.
 84. Navarro AM, Senn KL, McNicholas LJ, Kaplan RM, Roppe B, Campo MC. Por La Vida model intervention enhances use of cancer screening tests among Latinas. *Am J Prev Med* 1998;15:32–41.
 85. Burack RC, Gimotty PA, George J, et al. How reminders given to patients and physicians affected Pap smear use in a health maintenance organization: results of a randomized controlled trial. *Cancer* 1998;82:2391–400.
 86. Binstock MA, Geiger AM, Hackett JR, Yao JF. Pap smear outreach: a randomized controlled trial in an HMO. *Am J Prev Med* 1997;13:425–6.
 87. Sung JF, Blumenthal DS, Coates RJ, Williams JE, Alema-Mensah E, Liff JM. Effect of a cancer screening intervention conducted by lay health workers among inner-city women. *Am J Prev Med* 1997;13:51–7.
 88. Dignan M, Michielutte R, Blinson K, et al. Effectiveness of health education to increase screening for cervical cancer among eastern-band Cherokee Indian women in North Carolina. *J Natl Cancer Inst* 1996;88:1670–6.
 89. Yancey AK, Tanjasiri SP, Klein M, Tunder J. Increased cancer screening behavior in women of color by culturally sensitive video exposure. *Prev Med* 1995;24:142–8.
 90. Gonzales JJ, Ranney J, West J. Nurse-initiated health promotion prompting system in an internal medicine residents' clinic. *South Med J* 1989;82:342–4.
 91. Dickersin K, Scherer R, Lefebvre C. Identifying relevant studies for systematic reviews. *BMJ* 1994;309:1286–91.
 92. Cardozo LJ, Steinberg J, Lepczyk MB, Binns-Emerick L, Cardozo Y, Aranha AN. Improving preventive health care in a medical resident practice. *Arch Intern Med* 1998;158:261–4.
 93. Cheney C, Ramsdell JW. Effect of medical records' checklists on implementation of periodic health measures. *Am J Med* 1987;83:129–36.
 94. Clementz GL, Aldag JC, Gladfelter TT, Barclay AM, Brooks HF. A randomized study of cancer screening in a family practice setting using a recall model. *J Fam Pract* 1990;30:537–41.
 95. Cowan JA, Heckerling PS, Parker JB. Effect of a fact sheet reminder on performance of the periodic health examination: a randomized controlled trial. *Am J Prev Med* 1992;8:104–9.
 96. Dickey LL, Petitti D. A patient-held mini record to promote adult preventive care. *J Fam Pract* 1992;34:457–63.
 97. Dietrich AJ, O'Connor GT, Keller A, Carney PA, Levy D, Whaley FS. Cancer: improving early detection and prevention. A community practice randomized trial. *BMJ* 1992;304: 687–91.

98. Dietrich AJ, Tobin JN, Sox CH, et al. Cancer early-detection services in community health centers for the underserved. A randomized controlled trial. *Arch Fam Med* 1998;7:320-7.
99. Gemson DH, Ashford AR, Dickey LL, et al. Putting prevention into practice. Impact of a multifaceted physician education program on preventive services in the inner city. *Arch Intern Med* 1995; 155:2210-6.
100. Gotay CC, Banner RO, Matsunaga DS, et al. Impact of a culturally appropriate intervention on breast and cervical screening among native Hawaiian women. *Prev Med* 2000;31:529-37.
101. Hillman AL, Ripley K, Goldfarb N, Nuamah I, Weiner J, Lusk E. Physician financial incentives and feedback: failure to increase cancer screening in Medicaid managed care. *Am J Prev Med* 1998;88: 1699-701.
102. Kreuter MW, Strecher VJ. Do tailored behavior change messages enhance the effectiveness of health risk appraisal? Results from a randomized trial. *Health Educ Res* 1996;11:97-105.
103. Lantz PM, Stencil D, Lippert MT, Beversdorf S, Jaros L, Remington PL. Breast and cervical cancer screening in a low-income managed care sample: the efficacy of physician letters and phone calls. *Am J Public Health* 1995;85:834-6.
104. Litzelman DK, Dittus RS, Miller ME, Tierney WM. Requiring physicians to respond to computerized reminders improves their compliance with preventive care protocols. *J Gen Intern Med* 1993; 8:311-7.
105. Mandelblatt J, Traxler M, Lakin P, et al. A nurse practitioner intervention to increase breast and cervical cancer screening for poor, elderly black women. The Harlem Study Team. *J Gen Intern Med* 1993;8:173-8.
106. Manfredi C, Czaja R, Freels S, Trubitt M, Warnecke R, Lacey L. Prescribe for health. Improving cancer screening in physician practices serving low-income and minority populations. *Arch Fam Med* 1998;7:329-37.
107. McDonald CJ, Hui SL, Smith DM, et al. Reminders to physicians from an introspective computer medical record. A two-year randomized trial. *Ann Intern Med* 1984;100:130-8.
108. McPhee SJ, Bird JA, Jenkins CN, Fordham D. Promoting cancer screening. A randomized, controlled trial of three interventions. *Arch Intern Med* 1989;149:1866-72.
109. McPhee SJ, Bird JA, Fordham D, Rodnick JE, Osborn EH. Promoting cancer prevention activities by primary care physicians. Results of a randomized, controlled trial. *JAMA* 1991;266:538-44.
110. Melnikow J, Kohatsu ND, Chan BK. Put prevention into practice: a controlled evaluation. *Am J Public Health* 2000;90:1622-5.
111. Ornstein SM, Garr DR, Jenkins RG, Rust PF, Arnon A. Computer-generated physician and patient reminders. Tools to improve population adherence to selected preventive services. *J Fam Pract* 1991;32:82-90.
112. Reding DJ, Lappe KA, Krueger M, Kolehouse BL, Steneil D, Leer RA. Cancer screening and prevention in rural Wisconsin: the Greater Marshfield experience. *Wis Med J* 1997;96:32-7.
113. Rimer BK, Conaway M, Lyna P, et al. The impact of tailored interventions on a community health center population. *Patient Educ Couns* 1999;37: 125-40.
114. Robie PW. Improving and sustaining outpatient cancer screening by medicine residents. *South Med J* 1988;81:902-5.
115. Schreiner DT, Petrusa ER, Rettie CS, Kluge RM. Improving compliance with preventive medicine procedures in a house staff training program. *South Med J* 1988;81:1553-7.
116. Somkin CP, Hiatt RA, Hurley LB, Gruskin E, Ackerson L, Larson P. The effect of patient and provider reminders on mammography and Papanicolaou smear screening in large health maintenance organization. *Arch Intern Med* 1997;157:1658-64.
117. Sox CH, Dietrich AJ, Goldman DC, Provost EM. Improved access to women's health services for Alaska natives through community health aide training. *J Community Health* 1999;24:313-23.
118. Tape TG, Campbell JR. Computerized medical records and preventive health care: success depends on many factors. *Am J Med* 1993;94:619-25.
119. Tierney WM, Hui SL, McDonald CJ. Delayed feedback of physician performance versus immediate reminders to perform preventive care. Effects on physician compliance. *Med Care* 1986;24:659-66.
120. Turner RC, Waivers LE, O'Brien K. The effect of patient-carried reminder cards on the performance of health maintenance measures. *Arch Intern Med* 1990;150:645-7.
121. Turner BJ, Day SC, Borenstein B. A controlled trial to improve delivery of preventive care: physician or patient reminders? *J Gen Intern Med* 1989; 4:403-9.
122. Whitman S, Lacey L, Ansell D, Dell J, Chen E, Phillips CW. An intervention to increase breast and cervical cancer screening in low-income African-American women. *Fam Community Health* 1994; 17:56-63.
123. Williams RB, Boles M, Johnson RE. A patient-initiated system for preventive health care: a randomized trial in community-based primary care practices. *Arch Fam Med* 1998;7:338-45.
124. Becker DM, Gomez EB, Kaiser DL, Yoshihasi A, Hodge RH Jr. Improving preventive care at a medical clinic: how can the patient help? *Am J Prev Med* 1989;5:353-9.
125. Fineberg MV, Funkhouser AR, Marks M. Variation

- in medical practice: A review of the literature. In: Eisenberg JM, editor. *Doctors' decisions and the cost of medical care. The reasons for doctors' practice patterns and ways to change.* Ann Arbor: Health Administration Press, 1986:137-38.
126. Brownstein JN, Cheal N, Ackermann SP, Bassford TL, Campos-Outcalt D. Breast and cervical cancer screening in minority populations: a model for using lay health educators. *J Cancer Educ* 1992;7:321-6.
 127. Tatum C, Wilson A, Dignan M, Paskett ED, Velez R. Development and implementation of outreach strategies for breast and cervical cancer prevention among African American women. FoCaS Project. Forsyth County Cancer Screening. *J Cancer Educ* 1997;12:43-50.
 128. Mandelblatt J, Freeman H, Winczewski D, et al. Implementation of a breast and cervical cancer screening program in a public hospital emergency department. *Cancer Control Center of Harlem. Ann Emerg Med* 1996;28:493-8.
 129. Doyle JP, Parker RM, Jacobson TA, McNagny SE. Breast and cervical cancer screening in an inner-city medical walk-in clinic: taking advantage of an often missed opportunity. *Am J Prev Med* 1996;12:345-50.
 130. Holschneider CH, Felix JC, Satmary W, Johnson MT, Sandweiss LM, Montz FJ. A single-visit cervical carcinoma prevention program offered at an inner city church. A pilot project. *Cancer* 1999;86:2659-67.
 131. Mandelblatt J, Freeman H, Winczewski D, et al. The costs and effects of cervical cancer screening in a public hospital emergency room. The Cancer Control Center of Harlem. *Am J Public Health* 1997;87:1182-9.
 132. Yabroff KR, Mandelblatt JS. Interventions targeted toward patients to increase mammography use. *Cancer Epidemiol Biomarkers Prev* 1999;8:749-57.
 133. Mandelblatt JS, Yabroff KR. Effectiveness of interventions designed to increase mammography use: a meta-analysis of provider-targeted strategies. *Cancer Epidemiol Biomarkers Prev* 1999;8:759-67.
 134. Paskett ED, Tatum CM, Mack DW, Hoen H, Case LD, Velez R. Validation of self-reported breast and cervical cancer screening tests among low-income minority women. *Cancer Epidemiol Biomarkers Prev* 1996;5:721-6.
 135. Sawyer JA, Earp JA, Fletcher RH, Daye FF, Wynn TM. Accuracy of women's self-report of their last Pap smear. *Am J Public Health* 1989;79:1036-7.
 136. Etzi S, Lane DS, Grimson R. The use of mammography vans by low-income women: the accuracy of self-reports. *Am J Public Health* 1994;84:107-9.
 137. Suarez L, Goldman DA, Weiss NS. Validity of Pap smear and mammogram self-reports in a low-income Hispanic population. *Am J Prev Med* 1995;11:94-8.
 138. Gordon NP, Hiatt RA, Lampert DI. Concordance of self-reported data and medical record audit for six cancer screening procedures. *J Natl Cancer Inst* 1993;85:566-70.
 139. Divine GW, Brown JT, Frazier LM. The unit of analysis error in studies about physicians' patient care behavior. *J Gen Intern Med* 1992;7:623-9.