

Computer-Generated Physician and Patient Reminders Tools to Improve Population Adherence to Selected Preventive Services

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Despite an emerging consensus on appropriate preventive services, a minority of patients receive them. A study was undertaken to assess the impact of computer-generated reminders to adult patients, their physicians, or both patients and physicians on adherence to five recommended preventive services: cholesterol measurements, fecal occult blood testing, mammography, Papanicolaou smears, and tetanus immunization. During the academic year 1988–1989, all 7397 adult patients and their 49 physicians in a university family medicine clinical practice were randomized by practice group into one of four study groups: control, physician reminders, patient reminders, and both physician and patient reminders.

Adherence was defined in community-oriented

terms: the percentage of patients within each group who had received the preventive service in the recommended interval. During the study period, adherence to four of the five preventive services increased significantly, with the largest increases in the physician and patient reminder group: cholesterol measurements increased from 19.5% to 38.1%, fecal occult blood testing 9.3% to 27.0%, mammography 11.4% to 27.1%, and tetanus immunization 23.4% to 35.4% (for each increase, $P < .0001$, McNemar's chi-square test.) In general, increases were greater in blacks and in patients with any form of insurance coverage. Computer-based physician and patient reminder systems have great promise of improving adherence to preventive services in primary care settings. *J Fam Pract* 1991; 32:82-90.

Despite recent literature documenting the effectiveness of a number of preventive services,¹⁻⁵ the degree to which patients receive these services remains suboptimal. Physicians report better performance in their provision of preventive services⁶⁻¹² than actual measurements reveal,¹³⁻¹⁸ and a significant proportion of Americans, often those at greatest risk, fail to comply with recommended procedures.¹⁹⁻²⁶

Health promotion checklists²⁷ or flow sheets,²⁸ nurse-initiated reminders,^{29,30} mailed reminders,³¹ physician counseling,³² and administrative changes³³ result in improved adherence to preventive services but can require a significant amount of personnel time.

Computer-generated reminders to physicians³⁴⁻³⁹ or patients⁴⁰⁻⁴² have improved adherence to preventive services recommendations in primary care settings. Most published studies, however, have been limited either by analysis only of attending patients, focus on one preventive service, or assessment of physician compliance with a recommendation rather than patient receipt of a service. In addition, no studies have compared the use of computer-generated physician and patient reminders in a comprehensive preventive services program. This paper reports the results of a randomized clinical trial comparing the impact of computer-generated reminders to physicians, their patients, or both, on patient adherence to five preventive services in a university-based family medicine clinic.

Methods

The study was conducted in the Family Medicine Center at the Department of Family Medicine at the Medical

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University of South Carolina. At baseline, July 1, 1988, four cohorts were defined from the 7397 active patients 18 years of age or older. Active patients are members of families who have had a clinic visit by one of its members within the previous 2 years. Each cohort corresponded to one of the four separate practice groups.

The percentage of patients who were up to date with Frame's recommendations¹⁻³ for serum cholesterol measurements, fecal occult blood testing, mammography, Papanicolaou smears, and tetanus immunization were assessed through computerized medical records.⁴³ The specific recommendations used were as follows:

1. Serum cholesterol: every 4 years in adults younger than 70 years
2. Fecal occult blood testing: Six-slide occult blood test every 2 years between ages 40 and 50 years and annually thereafter
3. Mammography: Every year after the age of 50 years
4. Papanicolaou smears: Every 2 years for all women aged between 18 and 70 years
5. Tetanus immunization: Every 10 years after primary immunization series

To confirm the accuracy of the computerized database, manual chart audits of 500 patient records were performed. Kappa indices of concordance between the computer data and the data from the manual audits were fecal occult blood testing 0.83, Papanicolaou smear 0.94, cholesterol measurement 0.88, and tetanus vaccine 0.67. The mammography database was established for this study, and essentially 100% agreement with the paper chart was assumed for this study.

Following the baseline assessment, a 1-year intervention program was conducted. Patients and their physicians were randomly assigned by practice group into one of four study groups: control (group A), physician reminders (group B), patient reminders (group D), and both physician and patient reminders (group C). A diagram of the study design is presented in Figure 1. All groups received educational and administrative interventions. Group A received no further interventions. Physicians in group B received computerized reminders for any deficiencies in the five preventive services at the time of patient visits. Group D patients were sent two personalized letters describing the preventive services they lacked and requesting that they make an appointment with their physician to receive them. Group C received both of these interventions: physician reminders at the time of patient visits and personalized patient letters.

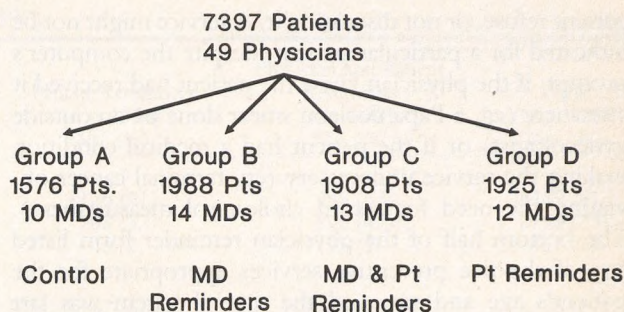


Figure 1. Diagram of study design.

Educational and Administrative Interventions

Since the study was conducted in a residency training program that historically had emphasized health promotion, it was elected to use educational and administrative interventions in all four study groups. Consequently, all resident physicians attended educational sessions about health promotion, including discussion of the five preventive services under study. These sessions occurred during designated family medicine months in the curriculum and the noon conference series. Residents could also receive instruction about health promotion by seeking consultation with the department clinical faculty, including two of the authors (D.R.G., S.M.O.). No special effort, however, was made during the study period to encourage faculty members to increase their emphasis on health promotion instruction. In addition to educational sessions, quarterly audits of the percentage of patients in each physician's practice who were up to date on the five preventive services studied were provided. Finally, a health maintenance flow sheet⁴ was placed in the medical record of all adult patients.

Physician Reminders

Physician reminder forms were generated by the computer system for each patient the night before a scheduled appointment. The reminders were generated by scanning each patient record for deficient preventive services based on the patient's age, sex, and last recorded time of the service. Forms were printed on single sheets of paper and attached to the medical record by nursing personnel the morning of the scheduled visit. The top half of the form listed identifying information and zero to five deficient preventive services. It contained boxes for the physician to mark, indicating his or her action on each particular reminder. Actions included ordering the preventive service that day, scheduling the patient to return for it another day, noting that it was not indicated for the patient, offering it to the patient but having the

patient refuse, or not discussing it. A service might not be indicated for a particular patient, despite the computer's prompt, if the physician knew the patient had received it elsewhere (eg, a Papanicolaou smear done by an outside gynecologist) or if the patient had a medical condition making the service unnecessary (eg, terminal cancer obviating the need for serum cholesterol measurement). The bottom half of the physician reminder form listed any of the five preventive services appropriate for the patient's age and sex, and the date the item was last received. The forms were collected daily by research assistants.

Patient Reminders

Patient reminder letters were generated by a similar computerized scan of the medical record. They were printed on letterhead stationery and signed by the patient's primary physician. The letter contained a brief description of the indicated preventive service(s) and suggested that the patient make an appointment with his or her primary physician to receive the recommended service(s). Physicians were permitted to withhold letters from individual patients if they felt this step was in the patient's best interest.

The first letter was sent in August 1988. Letters returned by the post office with forwarding addresses were remailed. The second letter was sent in January or February 1989. Patients whose first letters were returned without forwarding addresses were not sent a second letter.

Analyses

Preliminary assessments of the percentage of patients among the four groups who were up to date with the recommendations for the five preventive services were made quarterly: October 1, 1988, January 1, 1989, April 1, 1989, and July 1, 1989. Final assessments of adherence at baseline and at each quarter were made in the months following July 1, 1989, to account for late reporting of some services.

Descriptive statistics were used to describe physician characteristics and the baseline characteristics of the patient population. Patient race was categorized as black, white, or other. Insurance coverage was categorized as health maintenance organization (HMO) or preferred provider organization (PPO), other third party, Medicare or Medicaid, or uninsured. If a patient had more than one form of coverage, the first category on the list above was assigned. Age was assessed, in integer years, as of July 1, 1988. Differences between study groups at

baseline were compared with chi-square statistics for categorical data, and analysis of variance (ANOVA) for continuous data.

Changes between baseline and final adherence to the five preventive services recommendations were calculated by subtracting the percentage of patients adherent at baseline from the percentage adherent at study conclusion. Confidence intervals for differences of correlated proportions were calculated. The significant changes within each study group for each preventive service were determined by McNemar's chi-square test, as were the significant changes within groups defined by race and insurance coverage. To determine whether there were statistically significant differences in the changes in adherence to each preventive service among the study groups and groups defined by race and insurance coverage, chi-square tests of homogeneity stratified by baseline adherence were performed. For statistically significant chi-square tests of homogeneity ($P < .05$), multiple comparison chi-square tests were performed.

Results

Forty-nine family physicians practiced during the study period. Six were faculty members, one was a fellow, and 42 were residents (15 third year, 12 second year, and 15 first year). Sixteen of the residents were women. Four of the physicians left the practice during the study period, and their patients were reassigned to other physicians in their practice group.

The patient population was diverse (Table 1). The modal patient, however, was black, female, uninsured, and middle-aged. At baseline, most patients had made at least one clinic visit, and the mean duration of enrollment in the practice was 7 years. Statistically significant differences between study groups were present for race, insurance coverage, and visit frequency. White patients were overrepresented in the physician and patient reminder group. Although the groups had baseline differences in insurance coverage, the percentage of uninsured patients was similar in each group. The control group had the smallest percentage of patients who had never made a clinic visit.

In August 1988, patient reminder letters were sent and presumably received by 3283 (85.7%) of the 3833 patients in the two groups randomized to receive these letters. In January or February 1989, patient reminder letters were sent and presumably received by 3015 (78.7%) of the 3833 patients. The reasons letters were not received by the other patients in these two groups were presented in Table 2.

Forty-four percent of all study subjects made a visit

Table 1. Baseline Characteristics of the Patient Population (N = 7397)

Patient Characteristics	Control (n = 1576) No. (%)	Physician Reminders (n = 1988) No. (%)	Patient Reminders (n = 1925) No. (%)	Physician and Patient Reminders (n = 1908) No. (%)	Total (N = 7397) No. (%)
Race*					
Black	1081 (69)	1234 (62)	1176 (61)	998 (52)	4489 (61)
White	473 (30)	720 (36)	703 (37)	895 (47)	2791 (38)
Other	22 (1)	34 (2)	46 (2)	15 (1)	117 (2)
Sex					
Female	954 (61)	1230 (62)	1167 (61)	1135 (59)	4486 (61)
Male	622 (39)	758 (38)	758 (39)	773 (41)	2911 (39)
Insurance*					
HMO or PPO	82 (5)	128 (7)	179 (10)	193 (11)	582 (8)
Third party	496 (33)	647 (33)	645 (34)	598 (33)	2386 (33)
Medicare or Medicaid	319 (21)	347 (18)	312 (17)	323 (18)	1301 (18)
Uninsured	616 (41)	816 (42)	737 (39)	715 (39)	2884 (40)
History of visits*					
0 visits	226 (14)	311 (16)	384 (20)	334 (18)	1255 (17)
1 or more	1350 (86)	1677 (84)	1541 (80)	1574 (82)	6142 (83)
Mean age ±SD (years)	39.6 ± 17.7	39.9 ± 17.1	39.8 ± 17.0	40.8 ± 17.4	40.0 ± 17.3

* $P < .0001$ (chi-square). Totals add to greater than 100% because of rounding. Insurance coverage was unknown for 3% of the population. HMO—health maintenance organization; PPO—preferred provider organization.

during the year-long study period: 44.7% in the control group, 41.8% in the physician reminder group, 43.5% in the patient reminder group, and 46.3% in the physician and patient reminder group. These differences are statistically significant: $P = .03$ by chi-square analysis. Mean visit frequency was similar in all four groups: 1.9 ± 3.4 in the control group, 1.7 ± 3.1 in the physician reminder group, 1.8 ± 3.3 in the patient reminder group, and 1.8 ± 3.1 in the group receiving both types of reminders. These rates are not statistically significantly different: $P = 0.29$, by one-way ANOVA. Although visit frequency was greater in the quarters during which reminders were sent, there was no evidence that this effect was more pronounced in the groups that received patient reminders than in the groups that did not receive them.

During the study period, physician reminder forms

were printed in 7099 scheduled patient appointments. Of these appointments, 1715 (24.2%) were canceled, and 29 (0.4%) took place before a form was provided to the physician. Of the remaining 5355 appointments, physicians completed and returned the reminder form for 5096 (95.2%). These 5096 physician reminder forms provided prompts for 8158 specific activities: 1883 serum cholesterol determinations, 1817 fecal occult blood tests, 1038 mammograms, 1103 Papanicolaou smears, and 2317 tetanus immunizations. The physicians' responses to these 8158 reminders are presented in Table 3. Physicians addressed more than 70% of all reminders by ordering the service (29%), rescheduling the patient to receive it (13%), noting that it was not indicated (24%), or offering it to the patient but having it refused (5%). Refusal rates for all services other than mammography were 6% or less.

The percentage of patients who were up to date on serum cholesterol measurements, fecal occult blood testing, and tetanus immunization increased steadily throughout the year-long study in all four study groups (Table 4). Adherence to mammography recommendations increased in all four groups for the first three quarters and then declined slightly. Small, inconsistent declines in adherence to Papanicolaou smear recommendations occurred in all four groups. The increases from baseline to final assessment in serum cholesterol measurements, fecal occult blood testing, and tetanus immunization were statistically significant in all four study groups.

Table 2. Disposition of Patient Reminder Letters

Disposition	August 1988 (n = 3833)	Jan/Feb 1989 (n = 3833)
	No. (%)	No. (%)
Letter received	3283 (85.7)	3015 (78.7)
Returned undelivered	184 (4.8)	94 (2.5)
August 1988 reminders returned undelivered	—	184 (4.8)
Physician refusal	170 (4.4)	127 (3.3)
Up to date	127 (3.3)	310 (8.1)
Moved/no address	52 (1.4)	46 (1.2)
Deceased	17 (0.4)	35 (0.9)
Inactivated from practice	0 (0)	22 (0.6)

Table 3. Disposition of Physician Reminders*

Physician Response	Cholesterol (n = 1883) No. (%)	Fecal Occult Blood (n = 1817) No. (%)	Mammography (n = 1038) No. (%)	Papanicolaou Smear (n = 1103) No. (%)	Tetanus (n = 2317) No. (%)	Total (N = 8158) No. (%)
Ordered test	646 (34)	765 (42)	212 (20)	247 (22)	470 (20)	2340 (29)
Rescheduled	182 (10)	172 (9)	148 (14)	244 (22)	281 (12)	1027 (13)
Not indicated	472 (25)	320 (18)	183 (18)	356 (32)	646 (28)	1977 (24)
Patient refused	44 (2)	48 (3)	183 (18)	32 (3)	135 (6)	442 (5)
Did not discuss	394 (21)	379 (21)	251 (24)	158 (14)	593 (26)	1775 (22)
Blank	145 (8)	133 (7)	61 (6)	66 (6)	192 (8)	597 (7)

*Descriptions of physician responses are in the text. Column totals add to greater than 100% because of rounding.

Improvement in mammography adherence occurred in each study group except the group receiving patient reminder letters alone. A statistically significant decline in Papanicolaou smear adherence was confined to the physician reminder group.

There were statistically significant differences between study groups for the improvements noted in cholesterol measurements, fecal occult blood testing, mam-

mography, and tetanus immunization (Table 4). For cholesterol and fecal occult blood testing, improvement was significantly greater in the group receiving both physician and patient reminders ($P < .05$ for all pairwise comparisons between this group and the three others). For tetanus immunization, the three groups receiving reminders had better improvement than the control group ($P < .0001$ for these three pairwise comparisons).

Table 4. Quarterly Percentage Adherence and Change During Study Period to Five Preventive Services, by Study Group

Preventive Service	No.	7-1-88	10-1-88	1-1-89	4-1-89	7-1-89	Percentage Change and 95% Confidence Intervals 7-1-88 to 7-1-89	P Value*
Cholesterol								
Control	1422	19.2	21.9	24.0	26.6	28.3	9.1 (8.0, 10.1)	<.0001
Physician reminders	1826	22.9	29.4	31.8	33.6	35.2	12.3 (11.3, 13.2)	<.0001
Patient reminders	1768	17.5	23.9	25.6	29.2	31.1	13.6 (13.0, 14.3)	<.0001
Physician and patient reminders	1732	19.5	28.8	31.8	35.5	38.1	18.6 (17.8, 19.5)	<.0001†
Total	6748	19.8	26.2	28.5	31.5	33.4	13.6 (13.2, 14.0)	<.0001
Fecal occult blood								
Control	618	10.7	14.9	15.0	17.8	18.8	8.1 (4.7, 11.5)	<.0001
Physician reminders	818	18.1	21.6	22.4	24.7	23.2	5.1 (1.8, 8.5)	.0030
Patient reminders	782	14.7	19.2	20.3	22.4	23.4	8.7 (5.8, 11.6)	<.0001
Physician and patient reminders	815	9.3	19.3	22.6	26.5	27.0	17.7 (14.9, 20.4)	<.0001†
Total	3033	13.4	19.0	20.4	23.2	23.4	10.0 (8.4, 11.6)	<.0001
Mammography								
Control	266	11.7	16.2	18.4	27.8	27.4	15.7 (10.7, 20.9)	<.0001
Physician reminders	345	20.6	32.2	33.3	35.9	31.3	10.7 (4.7, 16.8)	.0009
Patient reminders	329	18.2	24.3	22.5	24.0	21.0	2.8 (-3.0, 8.5)	.35
Physician and patient reminders	332	11.4	20.8	23.2	27.7	27.1	15.7 (11.1, 20.2)	<.0001
Total	1272	15.7	23.8	24.8	29.0	26.7	11.0 (8.2, 13.8)	<.0001
Papanicolaou smear								
Control	843	46.0	45.8	45.3	45.7	45.1	-0.9 (-4.0, 2.1)	.54
Physician reminders	1111	43.8	44.4	42.8	41.4	39.3	-4.5 (-7.1, -1.9)	.001
Patient reminders	1054	37.4	38.2	38.3	37.2	35.3	-2.1 (-4.7, .5)	.12
Physician and patient reminders	1006	40.0	41.5	41.3	40.0	39.2	-0.8 (-3.7, 2.1)	.60
Total	4014	41.6	42.3	41.8	40.8	39.4	-2.2 (-3.6, -.8)	.0020
Tetanus vaccine								
Control	1576	18.2	18.6	19.6	21.2	22.0	3.8 (3.1, 4.4)	<.0001
Physician reminders	1988	23.6	29.0	31.3	33.0	34.2	10.5 (9.8, 11.3)	<.0001†
Patient reminders	1925	16.1	20.5	21.6	24.8	25.6	9.5 (8.9, 10.1)	<.0001†
Physician and patient reminders	1908	23.4	30.5	32.0	33.8	35.4	12.0 (11.2, 12.8)	<.0001†
Total	7397	20.4	25.0	26.5	28.5	29.6	9.2 (8.8, 9.5)	<.0001

*McNemar's chi-square test.

†Improvement significantly greater than in other groups by pairwise comparisons.

‡Improvements significantly greater than in control group by pairwise comparisons.

Table 5. Change in Percentage Adherence to Five Preventive Services, by Race and Insurance Coverage

Preventive Service	No.	7-1-88	7-1-89	Percentage Change and 95% Confidence Intervals	P Value*
				7-1-88 to 7-1-89	
Cholesterol					
Black	4107	19.2	34.6	15.4 (14.9, 16.0)	<.0001†
White	2531	21.0	31.7	10.7 (10.0, 11.5)	<.0001
HMO/PPO	581	37.5	59.4	21.9 (21.2, 22.5)	<.0001‡
Third party	2353	24.4	39.4	15.0 (14.3, 15.8)	<.0001
Medicare/Medicaid	748	27.9	52.8	24.9 (23.3, 26.4)	<.0001‡
Uninsured	2832	11.2	19.5	8.3 (7.6, 8.9)	<.0001
Fecal occult blood					
Black	1694	14.6	27.0	12.4 (10.2, 14.6)	<.0001†
White	1282	11.8	18.8	7.0 (4.7, 9.4)	<.0001
HMO/PPO	242	22.7	34.3	11.6 (4.5, 18.7)	.0025‡
Third party	922	13.9	22.3	8.4 (5.7, 11.2)	<.0001
Medicare/Medicaid	940	17.6	32.8	15.2 (11.8, 18.6)	<.0001‡
Uninsured	872	6.0	11.8	5.8 (3.8, 7.9)	<.0001
Mammography					
Black	751	17.0	29.8	12.8 (8.9, 16.7)	<.0001†
White	507	14.0	22.3	8.3 (4.3, 12.3)	.0001
HMO/PPO	52	40.4	51.9	11.5 (-6.3, 29.4)	.22§
Third party	254	22.8	28.4	5.6 (-1.5, 12.6)	.13
Medicare/Medicaid	657	14.2	29.5	15.3 (11.5, 19.2)	<.0001§
Uninsured	280	9.3	15.0	5.7 (.8, 10.6)	.030
Papanicolaou smear					
Black	2509	45.5	45.2	-0.3 (-2.2, 1.5)	.7
White	1455	35.1	30.0	-5.1 (-7.3, -3.0)	<.0001†
HMO/PPO	374	59.1	52.9	-6.2 (-11.3, -1.0)	.023
Third party	1383	44.8	44.8	0 (-2, 4, 2.4)	—
Medicare/Medicaid	575	52.2	52.2	0 (-4.0, 4.0)	—
Uninsured	1575	31.8	27.6	-4.2 (-6.3, -2.1)	.0001¶
Tetanus vaccine					
Black	4489	20.3	30.7	10.4 (10.0, 10.8)	<.0001†
White	2791	20.9	28.1	7.2 (6.5, 7.8)	<.0001
HMO/PPO	582	20.8	38.7	17.9 (16.7, 19.0)	<.0001‡
Third party	2386	20.4	30.3	9.9 (9.3, 10.5)	<.0001
Medicare/Medicaid	1301	30.8	47.2	16.4 (15.6, 17.3)	<.0001‡
Uninsured	2884	16.6	20.7	4.1 (3.5, 4.7)	<.0001

*McNemar's chi-square test.

†Changes statistically greater in these groups by chi-square tests of homogeneity, $P < .0001$.

‡Improvements in HMO/PPO and Medicare/Medicaid groups statistically greater than in others by pairwise comparisons.

§Improvements in HMO/PPO and Medicare/Medicaid groups statistically greater than in uninsured group by pairwise comparisons.

¶Declines in uninsured group statistically greater than in third party and Medicare/Medicaid groups by pairwise comparisons.

HMO—health maintenance organization; PPO—preferred provider organization.

For mammography, the overall difference between groups was of borderline statistical significance ($P = .04$), and the only significant pairwise comparison was between the physician and patient reminder groups ($P = .02$).

Significant improvements were observed for both blacks and whites in tetanus immunization, cholesterol measurements, fecal occult blood testing, and mammography (Table 5). Declines in adherence to Papanicolaou smear recommendations were significant only for white

subjects. Blacks had significantly greater improvement than whites in cholesterol measurements, fecal occult blood testing, mammography, and tetanus immunization and less decline in Papanicolaou smears. (Since only 117 patients in the practice cohort were of other races, they were excluded from these analyses.)

Statistically significant increases in serum cholesterol measurements, fecal occult blood testing, and tetanus immunization occurred for patients with HMO or PPO

coverage, Medicare or Medicaid, other third-party insurance, and in those who were uninsured (Table 5). For mammography, significant improvements were seen in patients with Medicare or Medicaid and in those who were uninsured. For Papanicolaou smears, declines occurred only for patients with HMO or PPO coverage and for those who were uninsured. There were statistically significant differences between the groups defined by insurance coverage for the improvements in cholesterol measurements, fecal occult blood testing, mammography, and tetanus immunization. Pairwise comparisons showed that improvement for each of these services was greater for patients with any form of coverage than for uninsured patients. Patients with Medicare or Medicaid coverage or HMO or PPO coverage had greater improvement than those with other third-party coverage in cholesterol determinations, fecal occult blood testing, and tetanus immunization. There were no significant differences between the groups with Medicare or Medicaid and HMO or PPO coverage for increases in any of these four services.

Discussion

This study has demonstrated that a 1-year, comprehensive preventive services program can dramatically increase adherence to four widely accepted preventive services in a well-defined population of family medicine patients. Administrative changes and education alone resulted in significant improvements. Computer-generated physician or patient reminders resulted in additional improvements in adherence to cholesterol and tetanus recommendations. The greatest improvements for cholesterol and fecal occult blood testing occurred when administrative changes and educational interventions were coupled to computer-generated reminders to both patients and their physicians.

Some of these findings have been documented in other studies. Frame et al³³ have demonstrated the utility of a combination of physician education and administrative changes in improving preventive services practices in the offices of community-based family physicians. McDonald et al³⁴ and Tierney et al³⁵ have demonstrated that internal medicine residents and faculty physicians will follow computer-generated prompts for preventive services, including fecal occult blood testing, mammography, and Papanicolaou smears, and that these prompts improve adherence to recommendations for these services. In a preliminary report from a smaller study, Tape et al³⁶ have reported similar findings for fecal occult blood testing, proctoscopy, and influenza vaccination. A more limited study,³⁷ examining the utility of microcomputer-

based physician prompts for mammography screening in a family medicine residency program, found improved physician ordering of mammography but did not measure actual patient receipt of the procedure. Computer-generated patient reminders have been shown to be effective for improving adherence to influenza vaccination⁴⁰ and Papanicolaou smears.⁴¹ A study comparing the efficacy of computer-generated physician and patient reminders for Papanicolaou smears found the latter intervention more efficacious.⁴² Finally, McPhee et al³⁹ found that computer-generated physician reminders increased patient compliance with six of seven cancer-screening procedures. This study, however, was limited to analyses of attending patients, and the magnitude of the intervention's effect may have been exaggerated by the manner in which compliance was computed.

The present report is the first to assess the combined impact of computer-generated physician and patient reminders on actual adherence to preventive services by a defined population of patients. The findings suggest that patient and physician reminders have an additive benefit in enhancing adherence to recommendations for preventive services. The improvements noted are particularly impressive, since the analyses performed used the "intention to treat approach" and included 4141 patients (60.0% of the population) who did not make a visit during the study period. In addition, the analyses included 1143 patients (15.4% of the original study population) who were no longer active in the practice at the end of the study period.

Several possible sources of confounding must be addressed. Differences in racial and insurance coverage distributions existed at baseline. These differences might confound the study findings if certain groups were more susceptible to the intervention. Confounding by race or insurance coverage, however, does not seem to have occurred. Blacks, underrepresented in the group receiving both patient and physician reminders, had greater improvements than whites, who were overrepresented in this group. Uninsured patients, those with the least improvement during the study period, were evenly distributed among the four study groups. The findings are also not confounded by the fact that two of the study investigators (D.R.G., S.M.O.) were two of the study physicians, since neither practiced in the group demonstrating the greatest improvements.

Several study findings deserve further comment.

That physicians addressed more than two thirds of all reminders is notable, since reminders were generated for all scheduled visits, regardless of purpose. The low rate of absolute patient refusal (5%) of these preventive services is also notable.

The more prominent impact of the intervention on

cholesterol measurements, fecal occult blood testing, and tetanus immunization may reflect the ease of incorporating these activities into a patient encounter. Cholesterol measurement and tetanus immunization can be done on site, with minimal disruption of routine. Fecal occult blood testing does require the patient to take the additional steps of sampling their stool and returning the test kit, but does not require additional contact with a health professional. Mammography and Papanicolaou smears generally require another encounter with a health professional.

Nonetheless, the slight decline in Papanicolaou smear adherence during the study period was unexpected. The intervention's lack of effect may be due to high baseline physician and patient awareness about recommendations for this procedure. In addition, the 32% response of "not indicated" on the physician reminder form suggests that many patients may have been receiving Papanicolaou smears elsewhere, or that they were not needed for medical reasons.

The small between-group differences in the percentage of patients who made a clinic visit during the study period and lack of difference in mean visit frequency was also surprising, as it had been anticipated that patients receiving reminder letters would make more visits. This hypothesis was supported by anecdotal reports from receptionists and nurses that many patients were making appointments on receipt of the letters. It is likely, therefore, that these visits were made in substitution of, rather than in addition to, visits that would have been made otherwise.

The dramatic improvements in adherence among patients with Medicare or Medicaid insurance were surprising. At the time the study was conducted, neither Medicare nor Medicaid reimbursed patients for the five preventive services studied.

Improvements in the control group were not unexpected, since the administrative interventions used in this group have proven to be effective.⁴³ In addition, since the four study groups were located in the same building, absolute blinding of participating physicians was impossible, and the Hawthorne effect may also have contributed to some of the improvements noted. Actual contamination of the study groups is unlikely, as physician and patient reminders were available only to those groups designated to receive them.

Other forms of bias⁴⁴ may have occurred in this study but are difficult to assess. Certain physicians may have been more competent than others in enhancing patient adherence to preventive services recommendations. If these physicians were unevenly distributed among the study groups, this factor, rather than the interventions themselves, may account for the observed

differences. Detection bias may have occurred for tetanus immunization, since data on this procedure done outside the clinic can be entered in the computer by clinic nurses. If either the physician or patient reminders resulted in more prompts to nurses to do so, this bias might have accounted for the greater improvement in tetanus immunization noted in these groups. A substantial effect of detection bias is unlikely, however, since baseline compliance was reassessed at study completion. Reports of tetanus vaccines performed before baseline, therefore, would not have been counted as improvement resulting from the interventions.

Generalizing the results of this study to other settings is problematic. Clinical settings without computer-based medical records will be unable to institute these interventions. In addition, clinical settings with patients or physicians better educated about preventive services might not respond as favorably to computer-based prompts. On the other hand, the high prevalence of uninsured patients in this practice population, and the evidence that improvement was greatest in those with insurance coverage, suggest that the effects of these interventions might be more prominent elsewhere. A more profound argument for the utility of computer-based prompting systems emerges from the recent report of the US Preventive Services Task Force.⁵ The extensive, risk-indicator-based series of recommendations in this report are ideally suited to computer-based screening and prompting systems. Nonetheless, the cost-effectiveness of computer-based medical records and reminder systems needs further study prior to more widespread implementation.

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