Computer-Based vs Manual Health Maintenance Tracking

A Controlled Trial

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Objective: To compare computer-based with manual health maintenance tracking systems to determine whether (1) a computer-based system will result in better provider compliance with the practice health maintenance protocol, (2) the incremental cost of operating a computer-based vs a manual health maintenance tracking system differs, and (3) inactive patients will respond to health maintenance reminders.

Design: Two-year prospective, randomized, controlled trial.

Setting: Rural, multiple-office, nonprofit, fee-for-service family practice.

Patients: Adult members of families in which at least one member had been seen by the practice within the past 2 years.

Intervention: A computer-based health maintenance tracking system that generated annual provider and patient reminders for all patients regardless of appointment status compared with a manual flowchart-based tracking system in which patient reminders were triggered by provider request.

Outcome Measures: Provider compliance with the health maintenance protocol determined by preintervention and postintervention chart audits, costs of computer-based tracking, and response of inactive patients to health maintenance reminders.

Results: Overall provider compliance with the health maintenance protocol increased 15 percentage points in the computer-based tracking group and four percentage points in the manual group. The computer-based tracking group had significantly higher provider compliance than the manual group for eight of 11 procedures. The computer-based tracking system cost 78 cents per patient per year to operate. It was not associated with increased office visits or patient billings.

Conclusions: Computer-based health maintenance tracking improved provider health maintenance compliance compared with a manual system. The finding that health maintenance compliance improved without a significant increase in patient visits or billings requires confirmation in other settings but suggests that considerable health maintenance can be incorporated into ongoing patient care.

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RESEARCH OF the past several decades has shown that primary and secondary prevention can play a major role in decreasing mortality from major health problems in adults, including heart disease, cancer, stroke, and infectious disease. Recommendations for preventive care in the primary care setting have been made by several authoritative groups.[1] In spite of these recommendations and evidence, physicians have been slow to incorporate routine health maintenance into their daily practice, and many patients do not receive regular preventive care.[2-4]

Tri-County Family Medicine (Dansville, NY) has used a manual, flowchart-based health maintenance tracking system since 1975.[5-8] In 1987, based on a study of the relation of screening to the detection of cancer in the practice, we became concerned that, even when compulsively used, the flowchart-based health

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METHODS

SETTING

Tri-County Family Medicine is a rural, nonprofit, group practice with headquarters in Dansville, NY (population, 6000). Tri-County cares for approximately 20 000 active patients in five offices with a medical staff of six full-time and one half-time family physicians and five physician's assistants. All offices, with the exception of the office of the principal investigator (P.S.F.), participated. The study design was reviewed and approved by the institutional review board of the University of Rochester (NY) School of Medicine and Dentistry.

A randomized list of guarantor (roughly equivalent to the head of the household) numbers, distributed among the four participating offices in proportion to the number of active patients at each office, was generated. Patients living in group homes and patients living outside the practice area were excluded. A family member was contacted by telephone to obtain demographic data on all adult family members. If a family could not be reached by telephone and a mailed questionnaire for the confirmation of the family composition and demographic data was not returned, the family was not included in the study. Families with no active members (active members being those seen within 2 years), those who had transferred their care elsewhere, and those whose charts could not be located were also excluded.

Each of the 1008 families included in the study was randomly assigned to either the computerized (trial) or manual (control) group. To assure balance, randomization was carried out within each of 32 strata based on the following four criteria: (1) office within the set of four participating, (2) whether the family included a woman older than 50 years, (3) whether all adult members were active, and (4) whether the family had any health insurance. The final study population consisted of 1665 adult family members, 829 in the trial group and 836 in the control group.

INTERVENTION

Provider compliance with a health maintenance protocol using the computer-based tracking system was compared with provider compliance using the manual flowchart-based system for adult patients (aged 21 years or older) during a 2-year intervention period (1991-1992). Thus, each patient in the computer-based trial group received two health maintenance reminders at annual intervals.

Compliance with 11 health maintenance procedures from the protocol recommended by Frame[5-8] was studied. The procedures included history of tobacco use (at any time), blood pressure measurement (within 2 years), weight measurement (within 4 years), serum cholesterol measurement (within 4 years, to age 70 years), fecal occult blood test (within 2 years between the ages of 40 and 50 years, annually for those older than 50 years), tetanus-diphtheria immunization (within 10 years), physician breast examination (every 2 years for women younger than 50 years, annually for women older than 50 years), mammography (annually for women older than 50 years), Papanicolaou test (within 2 years for women younger than 71 years), teaching self-examination (within 4 years), and teaching women to report postmenopausal bleeding (once for women older than 50 years).

The computer-based health maintenance tracking system developed for this project (HTRAK, Tri-County Family Medicine, Dansville) has been described previously.[14] HTRAK is written using FoxPro, a relational database manager that operates with DOS on IBM-compatible computers. The HTRAK software, operating on a microcomputer, was linked to the Tri-County Family Medicine billing system, which is written in RPG-2 language and uses IBM System-36 hardware (International Business Machines, Armonk, NY). The system was designed to include specific features believed necessary for a viable system in primary care practice. These features include that: (1) patient demographic data should be obtainable from the same files used for billing and administrative purposes; (2) data entry for all health maintenance procedures done on a given visit should be quick and preferably entered on a single screen; (3) multiple entry codes for each procedure should be available to encompass the range of provider and patient behaviors, including indications that the procedure was not indicated; the patient refused the procedure or the procedure was done elsewhere; and the procedure was done or not done; (4) it must be possible to generate reminders for patients regardless of whether they have recently been seen by the practice; (5) the system must allow providers to specify or cancel sending patient reminders as well as specify the month in which reminders will be sent; (6) a status report for the chart must be periodically updated and include notations of which procedures are due at that time; and (7) the global health maintenance protocol should be modifiable without the assistance of a computer programmer.

To use the HTRAK system, providers enter health maintenance data on the patient encounter form along with billing and diagnostic data during patient visits. The encounter form contains a listing of the practice health maintenance protocol with spaces to record when the procedures are done.[14] Six health maintenance status codes are available: D=procedure done and normal, X=procedure done but abnormal, N=procedure not indicated, R=patient refused the procedure, E=procedure done elsewhere, and I= previously abnormal but inactive problem (the "I" code might be used for a smoker who had quit). Use of an alternate frequency option allows the provider to specify that, for a particular patient, a procedure be repeated more (or less) frequently than the protocol requires. Data entry personnel enter health maintenance data from the encounter form into the billing computer after each visit at the same time billing and diagnostic data are entered.

Once a month, demographic and health maintenance data from the practice's billing system are downloaded into the microcomputer containing the HTRAK software. A health maintenance status report is created for both the patient and

provider once a year in the month of the patient's birth unless an alternate month has been designated, regardless of the patient's appointment status. The provider status report, shown in **Figure 1**, is placed on the front of the patient's chart yearly. It clearly shows the provider when procedures were done and which procedures are overdue. Providers can use the column on the right of the form to indicate procedures done at visits between the generation of the yearly reports.

The patient reminder is designed to be placed in a window envelope for direct mailing to the patient. The patient is encouraged to make an appointment for overdue health maintenance procedures and to show the reminder to the provider at each visit. In this study, however, telephone reminders were used instead of the mailed patient reminders to obtain additional data from patients about their health maintenance status (these additional data were not used to determine initial or final compliance results).

The manual flowchart-based health maintenance tracking system (**Figure 2**) used by providers for control patients has also been previously described.[8,15] The flowchart is placed on the front of each patient's chart. Providers mark procedures that are done and normal with a slash ("/") or abnormal procedures with an "X." They can also use code letters similar to those used in the computer-based system. In this study, control patients received telephone reminders for health maintenance only if requested by the provider.

A 2-hour provider instruction session was conducted by the principal investigator (P.S.F.) to teach providers how to use the computer-based system and the manual system. Printed instructions were given to all providers. In addition, providers had an opportunity to ask questions about either system at a staff meeting 1 month after the initial orientation. Throughout the 2-year intervention phase, care was taken neither to discuss the study with providers nor to give them feedback about performance or results.

To prevent providers from knowing which patients were in the study, half of all patients in the entire practice were assigned to the computer-based reminder system, which was indicated by a red dot affixed to the front of each patient's chart. The other half were assigned to the manual system, indicated by a green dot affixed to each chart.

Computer-generated provider reminders were placed on the charts of all "red-dot" patients annually. Nonstudy red-dot patients received a mailed computer-generated reminder annually. Prompted by a computer-generated patient reminder, study red-dot (trial) patients received a reminder telephone call or, if not reached, were mailed the patient reminder. Providers recorded data on the manual health maintenance flowchart for all "green-dot" patients. If the provider requested that a reminder postcard be sent, nonstudy patients received the postcard, while study control patients received a telephone reminder identical to that of the trial patients. Thus, providers knew they were to use the computer-based tracking system for red-dot patients and the manual system for green-dot patients but they were blinded to which patients were actually included in the study.

EVALUATION

A manual audit of charts of trial and control group patients was conducted prior to the 2-year intervention phase of the study to measure provider compliance for each procedure. The entire office chart was reviewed for as long as the patient had been in the practice. Chart audit data were the only data used to determine provider compliance. The provider was considered compliant if the procedure was done, the procedure was noted to be not indicated for that patient, the procedure was offered but the patient refused, or the provider noted that the procedure had been done elsewhere.

A final chart audit, similar to the initial audit, and a provider debriefing were conducted at the end of the intervention. Detailed records of the costs of operating the computer-based tracking system compared with the manual system were kept. Patient visits and billings for trial and control patients for the year prior to the intervention as well as the two intervention years were tracked to obtain information about the impact of the two systems on practice revenue and office visits.

Baseline characteristics of the trial and control groups and of initially active and not-active (inactive and never-seen) patients were compared using χ^2 tests (or Fisher's Exact Test) and t tests (or Mann-Whitney U test), as appropriate.

The changes in overall provider compliance between the initial and final audits for the two groups were compared using a t test, and a stepwise multiple regression was used to identify variables important in predicting change in compliance. The difference in change in compliance between the trial and control groups was estimated, along with a 95% confidence interval—with and without adjustment for other explanatory variables. The 196 patients who had never been seen were omitted from these analyses because their initial provider compliance was unknown and final compliance was known only for those who became active during the course of the study.

Within the trial and control groups, we compared changes between initial and final compliance for each procedure using an appropriate χ^2 test; we termed this difference the "net gain" in percentage compliance for that procedure. We then compared the trial group net gain with the control group net gain for each procedure.

Cost data for operating the computer-based tracking system were obtained by a time and motion study of different tasks during the second year of the intervention when employees were familiar with the system. Research costs and costs of installing the system were not included in the calculations. Patient reminder costs were calculated for generating mailed reminders (nonstudy red-dot patients) rather than telephone reminders as the system is primarily designed to generate mailed reminders. Records of patient visits and revenues billed to study patients were generated from the practice billing system. The patient visit and revenue data included most types of office visits: brief visits, standard visits, pelvic examinations, complex visits, and limited and complete physical examinations. Excluded from the calculations were hospital visits, obstetrical visits, and visits billed under workers' compensation.

Health Maintenance Status Physician Reminder

Office: Dansville Month Override: Physician:

Patient Name: Guarantor:
Date of Birth: Sex:
Date of Report: Age:

Procedure	Previously Done	Code	Last Done	Code	Overdue	Next Due	Done in Interim
History of tobacco use	/ /		06/22/92	D		/ /	__/__
Blood pressure	05/10/90	D	06/22/92	D		06/22/94	__/__
Serum cholesterol	/ /		06/22/89	D	YES	*NOW*	__/__
Fecal occult blood test for colon	05/10/90	D	06/22/92	D		06/22/94	__/__
Weight	/ /		06/22/92	X		06/22/96	__/__
Tetanus-diphtheria immunization	/ /		06/22/83	D	YES	*NOW*	__/__
Teach self-examination for lumps	/ /		05/10/90	D		05/10/94	__/__
Papanicolaou test	/ /		01/29/93	E		01/29/95	__/__
Physician breast examination	/ /		01/29/93	E		01/29/95	__/__
Evaluate for osteoporosis risk	/ /		/ /		YES	*NOW*	__/__

Figure 1. *Example of provider status report.*

maintenance tracking system was not reaching a significant inactive patient population.[9] This concern led to a review of existing computer-based health maintenance tracking systems and raised the question of whether a computer-based tracking system would be feasible, improve provider compliance, and reach inactive patients better than the manual flowchart-based system.

Computerized reminders to physicians and patients have been discussed for more than a decade. MacDonald et al[10] first reported improvement in physician behavior, including preventive procedures, because of computer-based prompting. However, despite the intuitive appeal of computer-based health maintenance tracking, there are few reports of implementing such systems in practice. Only three systems for tracking adult health maintenance, in addition to our current system, have recently been described.[11-13]

To our knowledge, no studies have directly compared the effectiveness and feasibility between computer-based and manual health maintenance tracking systems. Computer-based tracking offers several theoretical advantages over manual methods: (1) it is less dependent on provider motivation; (2) it easily generates reminders directly to patients regardless of activity status; (3) it is simple to change the global health maintenance protocol; (4) summary reports can be generated for quality assurance and to reinforce behavior; and (5) by requiring maintenance and support, it forces the practice to institutionalize preventive services.

Computer-based health maintenance tracking also has disadvantages compared with manual systems: (1) data entry can be time-consuming and, unless the medical record is totally computerized, may duplicate the manual chart; (2) it is relatively rigid and difficult to individualize to a particular patient or provider; and (3) it is more expensive and technically more complex than manual systems.

The purpose of this study was to determine the following: whether a computer-based system would improve provider compliance with the health maintenance protocol compared with a manual health maintenance tracking system; the feasibility and incremental cost of operating a computer-based system; and whether inactive patients would respond to health maintenance reminders.

RESULTS

BASELINE CHARACTERISTICS

Data on education and occupation show this to be primarily a blue-collar, lower-middle-class population. For 46% of the population, a high school diploma or equivalent was the highest degree, and 18% did not graduate from high school. Nine percent of the study population had no medical insurance, 9% received Medicaid, and 27% were covered by health maintenance organizations. Medicare provided the primary insurance for 18% of the study families. Overall, 62% of all patients had insurance that at least partially covered the cost of office visits. A higher percentage of the trial group had insurance coverage for office visits compared with the control group (65% vs 60%, respectively, $P=.06$). There were no other significant differences for baseline characteristics between the two groups.

One thousand three hundred twenty-four patients (80%) were initially active (seen at least once in the previous 2 years), with 145 (9%) patients initially classified as inactive and 196 (12%) never seen. Compared with active patients, those who were not active at baseline were more likely to be men, nonwhite, and to lack insurance to cover office visits, but the active and not-active groups did not differ significantly with respect to age or education.

CHANGE IN PROVIDER COMPLIANCE

Overall provider compliance was defined for each patient as the percentage of the procedures appropriate for that patient's age and gender that were actually offered by the provider. Among active and inactive patients, overall mean baseline compliance for all 11 procedures was 52%, with no significant difference between the trial and control groups.

The change in overall provider compliance for initially active patients was 13.5% in the trial group and 3.3% in the control group, a highly significant difference ($P<.001$). For initially inactive patients, the change in overall provider compliance was 27.1% in the trial group and 13.5% in the control group ($P=.02$). The statistical significance of the difference among inactive patients was limited by the small sample size. Regression analyses of patient factors predicting change in compliance identified being initially active as the only important predictor. Age, race, gender, and marital and insurance status were not predictors of change in provider compliance. Among initially active patients, marital status was an additional marginally significant predictor of change in compliance, with unmarried individuals having a slightly lower mean change in compliance ($P=.08$).

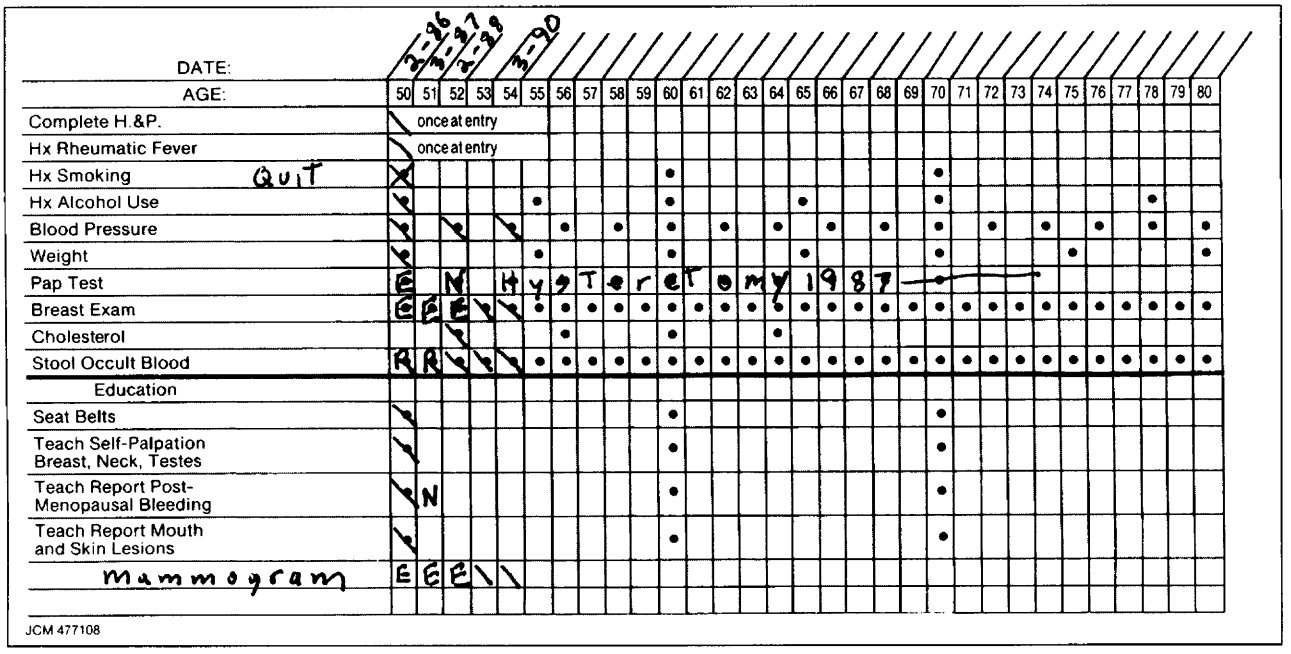

Figure 2. *Manual flowchart-based health maintenance tracking system. Dots indicate when procedure should be done. Slash ("/") indicates procedure done, result normal; X, procedure done, result abnormal; R, patient refused procedure; E, procedure done elsewhere; and N, procedure not indicated. Extra lines at the bottom allow for the addition of new procedures or individualization of the flowchart.*

COMPLIANCE ON INDIVIDUAL PROCEDURES

Changes in provider compliance for individual procedures are shown in **Table 1** and **Figure 3**. For the combined group of initially active and inactive patients, initial provider compliance on individual procedures varied from low compliance rates of 10% or less for counseling interventions (teaching about postmenopausal bleeding and self-examination techniques) to highs of over 80% of patients for the measurement of weight and blood pressure and tobacco use history. Screening interventions (fecal occult blood tests, mammograms, cholesterol measurements, breast examinations, and Papanicolaou tests) had intermediate initial provider compliance in the range of 37% to 53%.

Within the trial group, final compliance was significantly higher than initial compliance for all 11 procedures, with the exception of weight and blood pressure measurement, the latter being significantly lower at the final audit. In the control group, final compliance was significantly higher for only five procedures and was significantly lower for two. Those procedures with the largest increases (teaching self-examination, teaching to report postmenopausal bleeding, tetanus immunizations, cholesterol measurement, and tobacco use) were all ones that the protocol specified be done infrequently (at least 4 years between procedures). This meant that if the provider were initially compliant for a patient, no procedure would need to be repeated for many of these patients for that provider to still be compliant at the final audit. The increases in provider compliance for these procedures, therefore, primarily reflect new procedures being done.

The net difference in provider compliance in the two groups was significantly higher in the trial group than in the control group for all but three of the 11 procedures. These three procedures (history of tobacco use and weight and blood pressure measurement) had high initial compliance in both groups; the changes were approximately equal in the two groups and therefore not significant. Tetanus immunizations, which had a relatively low initial compliance rate in both groups, showed a dramatic increase of 36 percentage points in the trial group and 15 percentage points in the control group. The large difference for mammography (23 percentage points) was affected by the control group decrease.

COSTS OF COMPUTER-BASED TRACKING

The estimated costs of operating the computer-based health maintenance tracking system for the generation of 1000 patient and provider reminders are shown below.

Costs, $	Patient Reminders	Provider Reminders
Staff ($9.85/h)	162.53	182.23
Materials	92.50	52.50
Postage ($0.29/envelope)	290.00	0.00
Total	**545.03**	**234.73**

Provider time was equal for the manual and computer systems. The cost of maintaining the computer system, generating provider and patient reminders, and mailing patient reminders was 78 cents per patient per year. Two thirds of this cost relates to the generation and sending of patient reminders.

In a fee-for-service practice setting, the costs of operating the computer-based health maintenance tracking system might be expected to be partially or com-

Table 1. Provider Compliance for Each Procedure in Computer-Based (Trial) and Manual Tracking (Control) Groups*

	Trial Group					Control Group				
Procedure	n	Initial Compliance, %	Final Compliance, %	Net Difference	P	n	Initial Compliance, %	Final Compliance, %	Net Difference	P
Teach self-examination	725	4	41	+37	<.001	744	3	13	+10	<.001
Teach to report postmenopausal bleeding	128	9	48	+39	<.001	133	10	23	+13	<.001
Mammography	128	44	55	+11	.04	133	47	35	−12	.02
Tetanus booster	725	20	56	+36	<.001	744	21	36	+15	<.001
Fecal occult blood test	378	40	58	+18	<.001	398	34	37	+3	NS†
Clinical breast examination	400	49	57	+8	.01	406	47	44	−3	NS
Papanicolaou test	341	52	62	+10	.001	355	52	53	+1	NS
Cholesterol measurement	624	48	65	+17	<.001	644	45	56	+11	<.001
Blood pressure measurement	725	89	82	−7	<.001	744	86	76	−10	<.001
Weight measurement	725	93	94	+1	NS	744	94	93	−1	NS
History of tobacco use	725	82	93	+11	<.001	744	80	91	+11	<.001

*Includes initially active and inactive patients for whom the procedure was appropriate. Net differences are percentage point differences.
†NS indicates not significant.

pletely offset by increased revenues from additional patient visits or procedures. However, there was no increase in revenue generated or the number of office visits during the intervention years (**Table 2**). In 1990, the year before the intervention, the trial group had more visits and accounted for more billing than the control group. This trend continued during the study years, 1991 and 1992. Thus, computer-based tracking did not seem to lead toward either more office visits or more billings.

CHANGE IN ACTIVITY STATUS

The trial and control groups were initially similar in activity status, with 79% of patients initially active in the trial group and 80% initially active in the control group. A total of 269 (20%) of the initially active patients became inactive during the 2-year period, not an unexpected finding, presumably caused by normal patient turnover in the practice population and by the sporadic activity of some patients. At the final audit, a higher proportion (P=.059) of the trial group patients (73%) were active than the control group patients (69%).

Among initially active patients, 82% of the trial group and 78% of the control group were active at the final audit (P=.045). Among initially inactive patients, 51% of the trial group and 37% of the control group were active at the final audit (P=.081), but this apparent difference can be explained by differences in insurance status and office location.

COMMENT

Our study demonstrates the success of a computer-based tracking system in increasing provider compliance with health maintenance procedures. Overall, provider compliance for patients for whom providers used the computer-based system increased 15 percentage points compared with an increase of four percentage points when the manual flowchart system was used. Provider compliance on individual procedures was significantly increased in the trial group compared with the control group for eight of 11 procedures—an improvement that is both statistically and clinically significant. The computer-based system was moderately successful in maintaining the activity status of already active patients but was not shown to be successful in increasing activity in inactive or never-seen patients, possibly due to the small sample size of these groups.

The three procedures for which there were no significant differences between the manual and computer-based groups—blood pressure and weight measurement, and history of tobacco use—had high initial provider compliance (over 70%), and two of these procedures (measuring blood pressure and weight) are primarily the responsibility of nurses, who were not targeted in this intervention. We cannot explain the decrease in blood pressure measurement compliance in both the trial and control groups, although it could be because fewer study patients were active at the final audit than at the initial audit.

The cost of 78 cents per patient per year to operate the computer-based reminder system is reasonable; however, it does represent a significant operating expense for the practice. Somewhat surprising was the finding that additional office visits and overall revenue were not generated in the computer-based tracking group compared with the manual group. This may be partly because of the nonprofit status of the practice. Medicare and Medicaid pay on a cost-based, per-visit basis regardless of the complexity of the visit, and

Trial Group vs Control Group		
Net Difference	95% Confidence Interval	P
+27	23-31	<.001
+26	15-35	<.001
+23	9-40	.002
+21	16-26	<.001
+15	6-23	<.001
+11	2-19	.01
+9	1-19	.02
+6	1-11	.03
+3	−2-7	NS
+2	−1-4	NS
+0	−3-4	NS

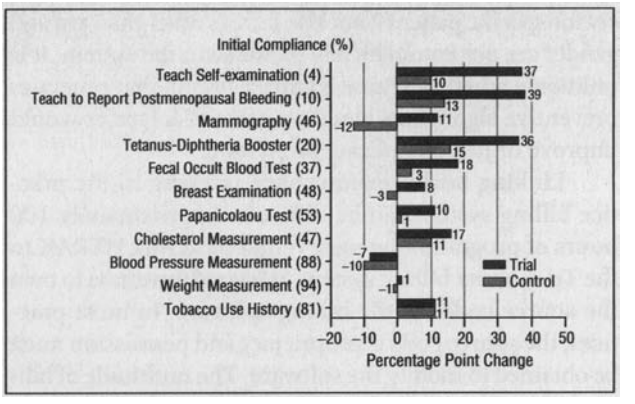

Figure 3. *Changes in provider compliance, by procedure, for computer-based (trial) and manual (control) health maintenance tracking systems groups.*

Table 2. Office Visits and Billings for Computer-Based Tracking (Trial) and Manual Tracking (Control) Groups

Group	Preintervention, 1991	Intervention 1991	Intervention 1992
Trial (n=829)			
No. of office visits	2189	2133	2028
Billings, $	54 834	58 201	57 604
Control (n=837)			
No. of office visits	1871	1944	1945
Billings, $	48 150	55 823	57 014

one health maintenance organization pays on a capitated basis. Furthermore, several of the Tri-County offices were working to capacity and not accepting new families. Different results might be obtained in practices looking to increase their patient volume. It should also be noted that Tri-County did not bill for cholesterol determinations, mammograms, and Papanicolaou tests because these procedures were done at outside facilities. Including the direct costs of these procedures would change the cost impact of performing increased health maintenance procedures. The revenue and visit results do suggest that a considerable amount of health maintenance is provided during patient visits scheduled for other reasons. This finding may be discouraging to the fee-for-service provider interested in increasing revenue but is encouraging for prepaid groups and health planners interested in providing preventive care at a reasonable cost.

LIMITATIONS

This study measured provider compliance, not patient compliance, which means that the patient was offered the intervention or that it was not indicated. It does not prove that patients changed their behavior based on the intervention or that the intervention was effective in reducing risk or preventing disease. Demonstrating such an effect would require a much longer, larger, and more sophisticated study. Mammograms, fecal occult blood testing, and, in one office, cholesterol determination required patient compliance to follow through with having the test completed. Also, providers were given credit for compliance if the test was documented to be not indicated, done elsewhere, or the patient refused. All these factors make provider compliance likely to be greater than actual patient compliance.

Because of the study selection process, we looked at inactive and never-seen members of active families rather than all inactive members of the practice. Many inactive patients living as individuals were not included because there was no active member of the family. This selection process decreased the number of inactive patients in the study to the point where we did not have adequate statistical power to show changes in activity status and compliance with individual tests among initially inactive patients.

The study did not address what component of the intervention caused the difference in provider compliance. Two different components were used, a provider chart reminder and a telephone patient reminder. We did not determine what portion of the improved compliance was due to each component of the intervention. Furthermore, telephone reminders were used for the study patients although the HTRAK system is primarily designed to generate mailed reminders. We used telephone reminders so we could gather information from the patients at the time of the reminder. Therefore, the relative merits of telephone vs mailed reminders could not be analyzed.

The HTRAK computer system is the most sophisticated computer-based health maintenance tracking system thus far tested in a community setting. In spite of this, it is a relatively simple system that generates protocols based only on age and gender. Providers can modify the proto-

col for specific patients, but risk factors other than age and gender are not automatically included in the system. It is unknown whether a more complex system that generates preventive algorithms based on other risk factors would improve or just complicate the system.

Linking health maintenance tracking to the practice billing system can be difficult. Approximately 100 hours of programming were required to link HTRAK to the Tri-County billing system. We were fortunate to own the source code for the billing software. In most practices, the source code is proprietary and permission must be obtained to modify the software. The multitude of billing software programs and the absence of a few dominant vendors means that linking clinical modules to existing billing systems will continue to be difficult. Ideally, billing software that includes a health maintenance tracking module would be available from commercial vendors. Stand-alone health maintenance tracking systems will be a viable option only if the current high effort and cost of duplicate data entry can be overcome.

The initiation of computer-based health maintenance tracking required improved maintenance of our billing database. Because reminders were being sent to all patients, it was necessary to periodically delete inappropriate patients from the system. Many patients were listed on the computer several times, which, if not identified, would cause multiple reminders to be sent to them.

The need to send only appropriate patient reminders can be a problem for reasons other than having an accurate database. Sending reminders to patients who are dead, terminally ill, seen while covering for another practice, or visiting from out of town is wasteful at best and potentially embarrassing. With the current version of HTRAK, providers need to remember to cancel reminders for these types of inappropriate patients.

One partial solution to the problem of sending inappropriate reminders is to have providers or staff specifically enroll patients in the health maintenance program rather than having the system send reminders to all patients unless they have been canceled. Enrolling patients will decrease inappropriate reminders but it runs the risk that reminders will not be sent to inactive or irregular patients who are the ones most in need of prompting and health maintenance.

RESEARCH QUESTIONS

This project has demonstrated the feasibility of using computers to track an entire health maintenance protocol and the superiority of the computer-based system compared with a manual system in one specific setting. Many important questions remain to be evaluated:

- Can similar systems be effective in other settings?
- What is the incremental benefit of sending direct patient reminders compared with generating only provider reminders?
- What is the effect of the specific protocol on provider compliance?
- Can a similar system be developed for children? How do you handle direct patient reminders in the pediatric age group?
- How can the development of computer-based health maintenance tracking be moved from a research mode to commercial products easily available to the primary care provider?
- What is the impact of health maintenance tracking on patient outcomes, including morbidity and mortality?

Improving provider compliance with health maintenance recommendations is a necessary component of achieving the goals of the *Healthy People 2000* campaign.[16] This study has shown computer-based health maintenance tracking to be a feasible, effective tool that is superior to manual health maintenance tracking for attaining the goal of offering rational preventive care to all patients.

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Reprint requests to Tri-County Family Medicine, Box 112, Cohocton, NY 14826 (Dr Frame).

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