

# Support of Quality and Business Goals by an Ambulatory Automated Medical Record System in Kaiser Permanente of Ohio

## CLINICAL INFORMATION SYSTEMS

SPECIAL EDITOR

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1998;1:73–82.

Kaiser Permanente of Ohio has developed a Medical Automated Record System (MARS) to address the business and clinical needs of the organization. The system is currently used by 220 physicians and 110 allied health personnel. To support the quality initiatives of the organization, the system has been programmed to generate reminders, at the moment of care, on compliance with clinical guidelines. This article details examples of compliance improvements with guidelines for the use of aspirin in coronary artery disease, use of influenza vaccinations in members older than 64 years of age, and stratification of asthmatic patients into severity levels; it also summarizes other quality improvements. MARS provides a data stream for electronic billing, which saves the organization the cost of manual billing. In addition, this system reduces operating costs, in particular the number of staff needed to deliver charts and the cost of printing forms. Cost-benefit analysis demonstrates that the system can produce savings in excess of maintenance costs.

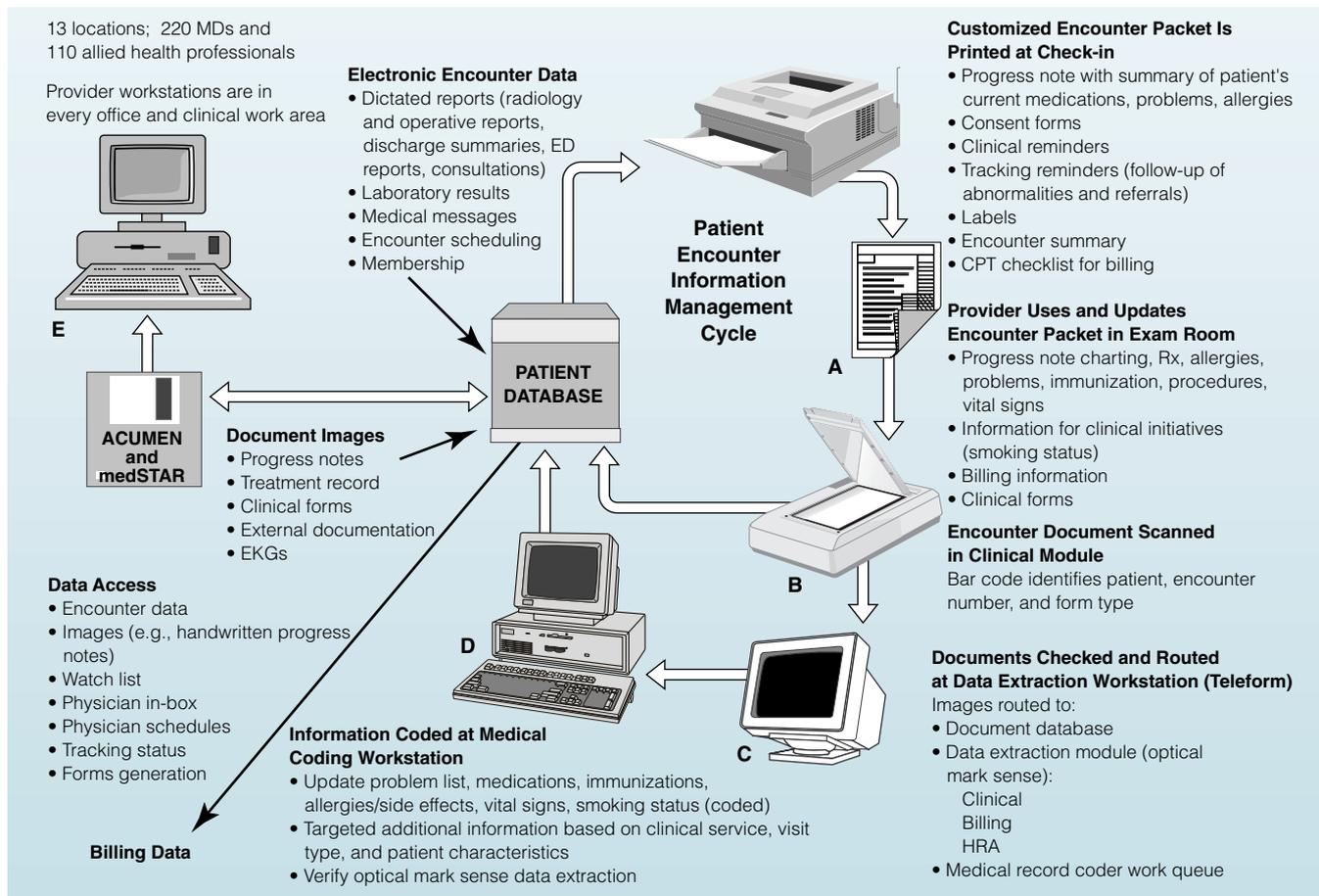
**K**aaiser Permanente of Ohio has a medical automated record system (MARS) that has been fully implemented in 13 ambulatory care locations in Cleveland and surrounding communities. This system is accessed for every patient encounter and is used routinely by 220 physicians and 110 allied health professionals. The system was developed to accomplish three goals: to improve the quality of care, to reduce organizational expense, and to produce a data stream to allow electronic billing.

### System Description

We believed that the system had to be acceptable to providers, require minimal training, and be possible to implement without decreasing provider productivity. It also had to capture information from sources outside of the organization, such as reports from consulting physicians. The approach selected involves personal computers that provide access to patient information in all clinician offices and work areas, a paper intermediary used to provide patient information and to capture clinician encounter documentation, and document imaging to enhance workflow and to capture non-electronic and optical mark sense information.

Figure 1 presents the overall flow of information management in MARS. A customized patient information packet (Figure 1, A) is printed in the clinical module when a patient checks in for a visit. The packet includes a progress sheet that contains a summary of patient information (e.g., current problems, medications, and allergies) and serves as a charting document (Figure 2). The provider notes new diagnoses, medications, allergies, immunizations, and vital signs in prescribed areas on the progress sheet (e.g., new diagnoses are added to the preprinted problem list). Progress notes are also handwritten on this sheet. In addition to the progress sheet, the packet contains a summary of diagnoses and vital signs from past visits, laboratory test results from the previous month, optical mark sense forms to collect coded information for billing and clinical intervention (Figure 3), and other forms (e.g., consent forms). Finally, the packet includes patient-specific clinical reminders generated in support of the organization's quality initiatives (Figure 4). The ability of computerized

*This paper is available at [ecp.acponline.org](http://ecp.acponline.org).*



**FIGURE 1. Information management in the medical automated record system of Kaiser Permanente of Ohio. ACUMEN = Ambulatory Clinical User Meaningful Enterprise Navigation; CPT = common procedure terminology; ED = emergency department; EKG = electrocardiogram; HRA = health risk assessment; Rx = prescriptions.**

reminders delivered at the moment of care to improve the quality of care delivered has been demonstrated (1–3). Research indicates that a simple reminder, generated at the moment of care, about actions that a physician intended to do but may have overlooked will result in the physician performing those actions.

Packets are customized for the clinical service rendered and type of appointment. The goal in customizing encounter packets was twofold. The system had to provide enough pertinent information from the medical record to minimize the need for clinicians to leave the examination room to access information from a personal computer. It also had to facilitate capture of the documentation and coded information needed to support clinical initiatives and billing. The provider uses and updates the packet during the patient encounter and can consult the computer in his or her office or in a clinical work area to obtain additional information (Figure 1, E).

Each page of the encounter packet that will be used as documentation is bar-coded to enable automatic indexing of scanned documents. At the conclusion of the encounter, a medical assistant in the clinical module optically scans all pages with bar codes (Figure 1, B).

Document images become part of the information accessible at any system computer by using medSTAR (Sequoia Software, Inc., Columbia, Maryland) and are transmitted to the medical records department for quality assurance and coding (Figure 1, D). In this process, entries on optical mark sense forms are also automatically extracted by computer (Figure 1, C).

Data are captured from several sources. The system is connected to the organization's membership and scheduling systems, which provide the information printed at the top of the progress sheet (Figure 2). Clinical dictations from the transcription system are also captured in the MARS database. As noted, document images are collected by optical scanning, and some data are automatically extracted from optical mark sense forms. Medical coders collect crucial data elements—diagnoses, medications, allergies, immunizations, vital signs, and smoking status—from the progress sheets. The handwritten progress note is captured by optical scanning, as is any documentation generated outside the organization. Finally, two of the three contract hospitals for the managed care organization have data links, which include dictated notes, laboratory tests, radiology

PROV: 00666 KHOURY, ALLAN M.D.  
INTERNAL MEDICINE  
LOC: 60 WILLOUGHBY MED. CENTER DATE: XX-XX-XX NAME:  
DSK: 2E MEDICINE 1 ADDRESS:  
APPT DATE: 00-25-1996 APPT TYPE: FU HOME: ( ) - WORK: ( ) - RECBASE:  
APPT TIME: 9:30 A CHK IN TIME: 9:25 A D.O.B.: XX-XX-XX SEX:  
ENCTR NBR: 0000000000000 GRP/SGRP: 1202-000 C00CX--0HA0X0

### PROGRESS SHEETS

#### VITAL SIGNS

Height *5ft 3in* Weight *175 lb.*  
BP *130/85*  
Pulse *72*  
Temp *98.3°F*

Age: 72 Yr. 6 Mo.

Primary: KHOURY, ALLAN M.D.

#### PROBLEMS

Circle the "1" or "2" to indicate primary or secondary diagnosis for this visit.

- 1 (2) HTN
- 1 2 H/O CARCINOMA OF BREAST
- 1 2 VENOUS STASIS CHANGES
- 1 2 R/O DISC DEGENERATION
- 1 2 S/P RIGHT BREAST LUMPECTOMY {1988}
- 1 2 HIATUS HERNIA
- 1 2 IRON DEFICIENCY ANEMIA
- 1 2 OSTEOARTHRITIS LT HIP
- 1 2 LT KNEE
- 1 2 BILATERAL STASIS ULCERS MEDIAL LOWER LEGS
- 1 2 SCALP DERMATITIS
- 1 2 SEBORRHEIC KERATOSES
- 1 2 NEVUS EXCISED
- 1 2 PAP {6/94}
- 1 2 DISORDER OF REFRACTION
- 1 2 PREGLAUCOMA NOS
- 1 2 STASIS ULCER RT ANKLE {RESOLVED}
- 1 2 MAMM {6/95}
- 1 (2) TYPE II DM
- 1 2 MEDIUM RISK FOR AMPUTATION
- 1 2 S/P TAH {USO IN 1976}
- (1) *DOE*

APPT LENGTH (MIN): 10 15 20 30 40 45 60 \_\_\_\_\_

#### REASON FOR VISIT:

*Routine f/u*  
*Notes occasional shortness of breath*

Have you smoked in the last 6 months? (Prev. NO) YES (NO)

If yes, do you smoke now? (Prev. NO) YES (NO)

#### IMMUNIZATION HISTORY

FLU SHOT 11-16-1992 10-26-1995  
PNEUMOVAX 11-08-1994

#### ALLERGIES/SIDE EFFECTS

NKA

#### CURRENT MEDICATIONS IN DATABASE

1. Nolvadex 10/mg tab; 1 PO BID; 180; #REF 1; 09-25-1995; Khoury, Allan M.D.
2. Hydrochlorothiazide 25/mg tab; 1 PO QD; 90; # REF 1; 09-25-1995; Khoury, Allan M.D.
3. Lotrimin 1%/ soln; use around affected nails bid; 10 CC; # REF 1; 12-03-1992; Packer, Clifford M.D.
4. Tagamet 400/mg tab; 1 PO BID as needed; 100; # REF 2; 05-01-1995; Khoury, Allan M.D.
5. Tylenol 325/mg tab; 2 tabs Q4H as needed; # REF 0; 12-03-1992; Packer, Clifford M.D.
6. Lidex .05%/ soln; apply to scalp QD as needed flaking; 60 CC; # REF 6; 05-01-1995; Khoury, Allan M.D.
7. Clinoril 200/mg tab; 1PO BID with food; 60 # REF 2; 12-03-1992; Packer, Clifford M.D.
8. Betamethasone valerate .1%/ CRM; Apply to affected area BID PRN; 15 gm; # REF 1; 11-02-1993; Packer, Clifford M.D.
9. Fungoid Tincture liq; Apply QD to affected nails; 30 ml; # REF 0; 05-18-1994; Packer, Clifford M.D.
10. K-DUR 20/MEQ tab; 1 tab PO QD; 200; # REF 1; 09-25-1995; Khoury, Allan M.D.

#### OTHER CURRENT MEDICATIONS, LIST BELOW:

*The patient has DOE with activities such as climbing stairs. Denies orthopnea, PND. No cough or fever. No chest pain. This began about 1 month ago. FBS at home 100-125.*

**FIGURE 2. A progress sheet that contains a summary of patient information and serves as a charting document in the medical automated record system. BID = twice daily; CRM = cream; DM = diabetes mellitus; DOE = dyspnea on exertion; f/u = follow-up; H/O = history of; HTN = hypertension; LIQ = liquid; LT = left; MAMM = mammography; NKA = no known allergies; PAP = Papanicolaou smear; PND = paroxysmal nocturnal dyspnea; PO = orally; Q = every; QD = every day; R/O = rule out; RT = right; S/P = status post; TAB = tablet; TAH = total abdominal hysterectomy; USO = unilateral salpingo-oophorectomy.**

reports, and special procedure results. The link with the Cleveland Clinic Foundation, for example, is made electronically by using their Datagate interface engine.

All data (except scanned images) are stored on the organization's mainframe computer in an Integrated Data Management System/Multiple Virtual Systems database. Images are stored on servers in each clinical

office in a structured query language database, which runs on a computer with a Windows NT (Microsoft Corp., Redmond, Washington) operating system. Information access by clients is simplified by Ambulatory Clinical User Meaningful Enterprise Navigation [ACUMEN], an internally developed graphical user interface for mainframe data, and by medSTAR, which is used to

PROV: 00666 KHOURY, ALLAN M.D.  
 INTERNAL MEDICINE  
 LOC: 60 WILLOUGHBY MED. CENTER  
 DSK: 2E MEDICINE 3  
 APPT DATE: 02-24-1997 APPT TYPE: FA  
 APPT TIME: 12:00 P CHK IN TIME: 11:41 A  
 ENCTR NBR: 000000000000

DATE: XX-XX-XX NAME:  
 ADDRESS:  
 HOME: ( ) - WORK: ( ) - RECBASE:  
 D.O.B.: XX-XX-XX SEX:  
 GRP/SGRP: 1502-001 WOORV-X-OHADXO

**Adult Medicine/Health Appraisal Checklist – Page 1**

Bubble correction made on checklist

**Indicate the procedure by completing the circles**

**PHYSICIAN PROCEDURES**

- ABG 82803
- Anoscopy 46600

Arthrocentesis/aspiration/injection

- small joint 20600
- intermediate joint 20605
- major joint 20610
- EKG interpretation 93000
- Flexible sigmoidoscopy 45330
- I & D abscess 10060

Interpretation

- Vaginal wet prep 87210
- Vaginal KOH prep 87220
- Mole/wart removal 17110
- PAP smear 88150
- Peak flow 94160
- Pulmonary function study 94620
- Removal of cerumen 69210
- Rigid sigmoidoscopy 45300
- Rhythm strip & interpretation 93042
- Skin tag removal 11200
- Soft tissue injection 20550
- Stool card w/interpretation 82270.26
- Toenail trim 11750
- X-ray interpretation 76140

**IMMUNIZATIONS**

Refused



- Hepatitis A (Havrix) 90730
- Hepatitis B 90731
- Influenza 90724
- Pneumococcus 90732
- Td-adult (tetanus) 90718
- MMR 90707
- Measles 90705
- Mumps 90704
- Rubella 90706
- Gammaglobulin (passive) 90741
- Gammaglobulin (therapeutic) 90782
- Chicken pox 90716

**NON KP HISTORY**

- Mammogram 76090 

--	--	--	--	--	--
- Pap Test 88150 

--	--	--	--	--	--
- Dilated Retinal Exam 92499 

--	--	--	--	--	--
- Cholesterol Screening 83718 

--	--	--	--	--	--
- Flu immunization 90724 

1	2	1	3	9	6
---	---	---	---	---	---
- Other \_\_\_\_\_

**Date Performed MMDYY**

**INDICATE VISIT COMPLEXITY LEVELS BELOW**

**History**

- Problem Focused
- Expanded
- Detailed
- Comprehensive

**Exam**

- Problem Focused
- Expanded
- Detailed
- Comprehensive

**Decision**

- Straightforward
- Low Complexity
- Moderate Complexity
- High Complexity

**FIGURE 3. An optical mark sense form. ABG = arterial blood gas; EKG = electrocardiography; I & D = incision and drainage; KOH = potassium hydroxide; KP = Kaiser Permanente; MMR = measles, mumps, and rubella; Pap = Papanicolaou; Td = tetanus-diphtheria.**

retrieve and manipulate images. Packets to be printed are constructed by using a Microsoft Access database.

Except for the appointment and registration systems and the software developed by Sequoia Software (medSTAR, a master patient index, and the software used to print the paper packet through Microsoft Access), the system was developed internally.

**System Acceptance**

A complete technical description of the system is available in the 1997 Proceedings of the Computer-based Patient Record Institute (4). By all measures, the system has been successful. Implementation has been completed in all ambulatory care sites. Physician acceptance of

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INTERNAL MEDICINE  
LOC: 60 WILLOUGHBY MED. CENTER  
DSK: 2E MEDICINE 3  
APPT DATE: 01-13-1997 APPT TYPE: FA  
APPT TIME: 1:30 P CHK IN TIME: 1:19 P  
ENCTR NBR: 0000000000000

### REMINDER SHEETS

#### DO NOT SCAN

DATE: XX-XX-XX NAME:  
ADDRESS:  
HOME: ( ) - WORK: ( ) - RECBASE:  
D.O.B.: XX-XX-XX SEX:  
GRP/SGRP: 2107-001 Z00RU-X-OHAD XO

#### \*\*\* REMINDER NOTICE \*\*\*

**DO NOT CHART \*\* DO NOT CHART \*\* DO NOT CHART**

**DO NOT WRITE NOTES ON REMINDER – USE PROGRESS SHEET**

Your patient has been identified by the encounter system as having coronary heart disease (CHD). Consider the use of aspirin, because in patients with known CHD, aspirin has been shown to reduce the incidence of future cardiovascular events.  
(Reference: NEJM 1992; 327:175-181.)

Your patient has been identified by the encounter system as having had a previous MI. If the MI occurred within the past 2 years and was a transmural infarction, the use of beta-blockers has been shown to reduce subsequent mortality due to coronary heart disease in this setting. Definite contraindications to beta-blockade include: Heart rate less than 60/min, systolic BP less than 100 mm Hg, moderate to severe LV failure, type I and II AV block or complete heart block, asthma, and severe COPD.  
(Reference: JACC 1990; 16: 249-292.)

Your patient with CHD has been identified as having an LDL cholesterol of 134 mg% on 10/06/97. Randomized trials have shown that lowering LDL cholesterol levels reduces recurrent CHD events. Consider the use of a cholesterol-lowering diet and a lipid-lowering agent (simvastatin [Zocor] is our preferred agent when higher doses of a statin are needed) to achieve the target goal of an LDL level of 100 mg% or less. Remember that statins are contraindicated in pregnant patients and interact with Coumadin.

**FIGURE 4. A patient-specific clinical reminder. AV = atrioventricular; BP = blood pressure; CHD = coronary heart disease; COPD = chronic obstructive pulmonary disease; LDL = low-density lipoprotein; LV = left ventricular; MI = myocardial infarction.**

the information management approach has allowed incorporation of the system into the routine care process, with the result that it is used for every patient encounter.

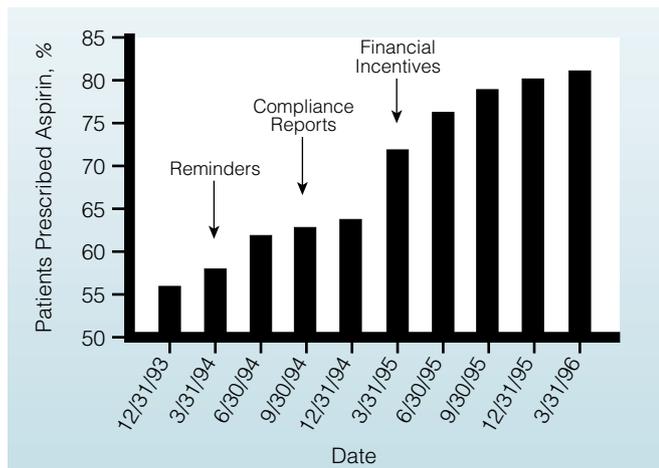
Our approach has met all of the operational requirements stated at the outset: provider acceptance, minimal training, minor changes in physician documentation tasks (physicians record diagnoses, medications, allergies, and immunizations in prescribed data fields on encounter turnaround documents), and no decrease in productivity.

### Support of a Quality Program

The most important reason for building the MARS database was to support Kaiser Permanente's quality program, which has several threads. Major goals of this program are to achieve excellence in Health Plan Employer Data Information Set (HEDIS) performance for the organization and to support the organization's

strategic quality plan. This plan is based on an analysis of the Healthy People 2000 initiative (5). As a result, clinical areas were identified in which investments in health care improvement would lead to substantial quality improvement.

For example, a reminder to use aspirin in coronary artery disease is shown in Figure 4. Figure 5 shows improved compliance with the guideline for aspirin use in coronary artery disease. Approximately 95% of the organization's 7000 members with coronary artery disease had at least one visit during the intervention period. The increases in compliance are statistically significant ( $P < 0.001$  by analysis of proportions [Stat Power, QEI Systems, Portland, Oregon]). The pattern of improvement is a typical response to the activation of a reminder. Use of reminders, in conjunction with batch reports to physicians comparing their compliance with that of colleagues, usually brings about improvement in compli-



**FIGURE 5. Compliance with aspirin use in patients with coronary artery disease.**

ance. Financial incentives were also used in the aspirin–coronary artery disease intervention; this may have contributed to the increase in compliance from 72% to 81%.

Reminders were also used to stratify the entire population of patients with asthma into levels of severity. The intent was to provide appropriate interventions at each asthma severity level. To do this, the stratification tool developed by the Managed Health Care Association was used (6) (Figure 6). Visits by asthmatic patients who had not been stratified for severity caused generation of a reminder that described the stratification tool for the physician. Notation of risk level in the diagnosis column by the physician inactivated the reminder. However, categorization of the patient as having moderate or severe asthma caused another reminder to print at subsequent visits if the patient was not using an anti-inflammatory inhaler. Results of asthma severity stratification are shown in Figure 7. The reminder was activated in April of 1995. As of this writing, two thirds of the population has been stratified.

The reminder about the use of anti-inflammatory inhalers for patients with moderate or severe asthma was implemented in September 1996. Analysis showed that compliance with this guideline was already high at 70% to 86% in the adult and pediatric populations (a different stratification approach was used for the latter group). Subsequent work has focused on compliance with the use of anti-inflammatory inhalers by patients with moderate or severe asthma. The analysis uses pharmacy dispensing data; fewer than four canisters dispensed in 6 months indicates noncompliance. The initial analysis indicated that many patients were noncompliant. Consequently, a new reminder has been created that notes, at the time of a visit, whether a patient with moderate or severe asthma who has already been prescribed

an anti-inflammatory inhaler is not compliant with the therapy.

Figure 4 shows how several reminders might be generated at a patient visit. The use of reminders has led to improved compliance with guidelines for treatment of coronary artery disease, congestive heart failure, asthma, diabetes, and hypertension (Table 1). These are areas in which measurements have been made; reminders also address many other areas, such as the need for mammography and Papanicolaou tests. However, simultaneous organization initiatives cloud the importance of the reminders in improving performance.

Reminders usually result in some improvement in compliance. The addition of batch reports that are given to each physician and measure compliance relative to that of colleagues further improves compliance. However, because experimental comparisons of batch reports plus reminders with batch reports or reminders alone were not done, we cannot determine which interventions contributed more to compliance. Moreover, full compliance with a guideline takes approximately 3 years; this is not surprising, given that patients may not be seen for some time after a new reminder is created and physicians may not have time to act on a particular guideline each time the patient is seen.

Certain guidelines require more complex additional interventions. For instance, during influenza season, a reminder is printed if the patient being seen is older than 64 years of age and has not had an influenza vaccination. In addition, on November 15 of each year, a computer tape is prepared that lists all patients in the appropriate age range who have not had an influenza vaccination. These data are used to activate a telephone calling device known as Teleminder (7) that calls the appropriate patients and suggests a vaccination. Because many members received influenza vaccinations outside Kaiser Permanente (e.g., in the workplace or at a senior center), Teleminder was programmed in 1995 to ask if this was the case; “yes” and “no” responses were analyzed. The results of the organization’s influenza vaccination program are shown in Table 2.

Another, more complex intervention is the process that supports a smoking cessation program (8). In the internal medicine department at Kaiser Permanente, questions about smoking are printed on the progress sheet to remind the nurse to ask them. If the patient is smoking, the physician expresses concern and suggests that the patient be referred to an interventionist, a specially trained nurse in the medical module. If the patient agrees to see a nurse interventionist, the actions taken are noted directly in the mainframe database by the nurse. Quarterly reports on compliance with guidelines are mailed to physicians and office management staff. In

PROV: 00666 KHOURY, ALLAN M.D.  
 INTERNAL MEDICINE  
 LOC: 60 WILLOUGHBY MED. CENTER  
 DSK: 2D MEDICINE 2  
 APPT DATE: 01-13-1997  
 APPT TIME: 3:00 P  
 ENCTR NBR: 000000000000

**DO NOT SCAN**

DATE: XX-XX-XX NAME:  
 ADDRESS:  
 HOME: ( ) - WORK: ( ) - RECBASE:  
 D.O.B.: XX-XX-XX SEX:  
 GRP/SGRP: 2928-000 CA0HS-A-0LABXX

**REMINDER SHEETS**

**\*\*\* REMINDER NOTICE \*\*\***

**DO NOT CHART    \*\*    DO NOT CHART    \*\*    DO NOT CHART**  
**DO NOT WRITE NOTES ON REMINDER – USE PROGRESS SHEET**

**Medical Reminders:**

FLU IMMUNIZATION SINCE 09/15/96  
 FLU IMMUNIZATION IS RECOMMENDED FOR THIS PATIENT

Please ask the patient about wheezing, chest tightness, and shortness of breath to determine asthma level.

**\*\* SYMPTOM FREQUENCY \*\***

SEVERITY LEVEL	DAYTIME FREQUENCY	NOCTURNAL FREQUENCY	SYMPTOM CHRONICITY
MILD	MILD SYMPTOMS, NOT MORE THAN ONCE A WEEK	NOT MORE THAN ONCE A MONTH	ASYMPTOMATIC BETWEEN EXACERBATIONS
MODERATE	EXACERBATIONS 2-5 TIMES A WEEK	2-7 TIMES A MONTH	SOME SYMPTOMS ON MOST DAYS, REQUIRING INHALER FOR RELIEF
SEVERE	FREQUENT EXACERBATIONS, MORE THAN 5 TIMES A WEEK	FREQUENT NOCTURNAL SYMPTOMS, MORE THAN 7 TIMES A MONTH	SYMPTOMS MOST OF THE TIME

The severity level to be chosen should be based on the greatest frequency or chronicity of wheezing, chest tightness, or shortness of breath. Thus, a person who reported shortness of breath more than 5 times a week, but other symptoms less often, would be classified as having severe asthma. This algorithm was derived from results of the Managed Health Care Association's asthma outcomes trial.

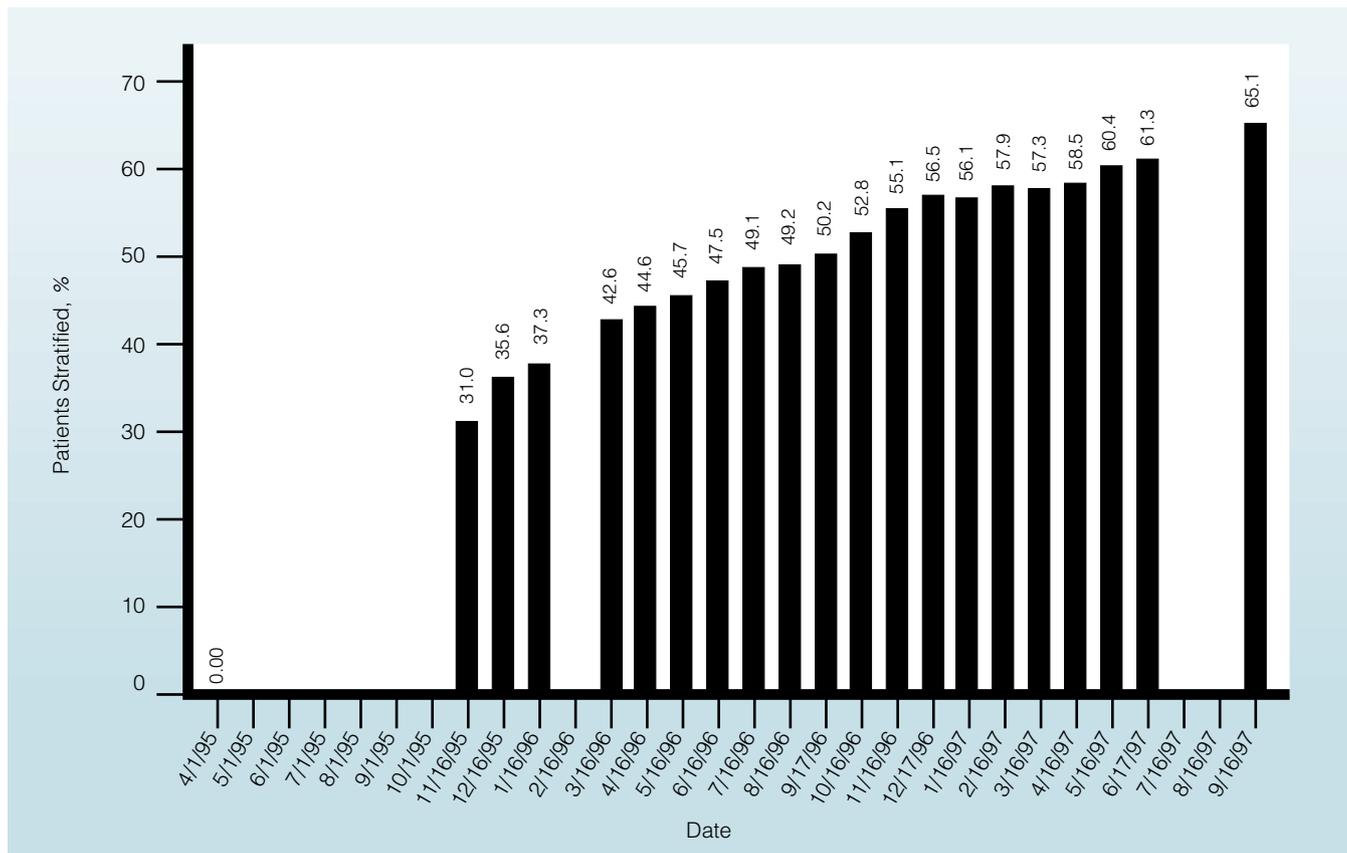
\*\*\*\*\* PLEASE ADD THE APPROPRIATE SEVERITY LEVEL TO THE DIAGNOSIS OF ASTHMA \*\*\*\*\*  
 \*\*\*\*\* E.G., ASTHMA – SEVERE (OR) SEVERE ASTHMA \*\*\*\*\*

**FIGURE 6. The stratification tool developed by the Managed Health Care Association. For further information, see reference 6.**

this way, each step in the process of smoking cessation can be assessed. A 1996 analysis indicated that the smoking status question is asked at 80% of adult primary care visits. When patients indicated that they were smoking, physicians addressed this issue 70% of the time at the onset of the program and approximately 50% of the time after it had been place for 18 months. (The reasons for the decreased physician compliance are unclear, but discomfort with repeating the advice to the same member was one reason offered.) Self-reported smoking prevalence has decreased from 23% to 20% of the adult membership since the program began in 1993.

**Support of Organizational Business Goals**

One of the goals of the MARS database was to reduce organizational expenses in three ways. One strategy was to reduce the number of people needed to maintain a complicated paper chart system. The second strategy was to eliminate the purchasing, warehousing, and distribution of approximately 200 clinical forms used in the organization. The organization is well on its way to meeting these goals. The number of employees in the medical records department who deliver charts has been reduced from approximately 100 to 35



**FIGURE 7. Results of stratification scheme for patients with asthma. The numbers at the top of the bars represent the exact percentage of stratified patients.**

through decreased ad hoc chart requests and the elimination of automatic delivery of charts for same-day appointments. Now that the MARS database has been available to all offices for at least 1 year, a program is in place to stop automatic delivery of all charts; however, ad hoc requests will still be permitted. Progress notes will be filed in charts for 12 more months; after that, they will be packaged on a daily basis for off-site storage. A new office building without a chart room is under construction; occupation is scheduled for January 1999. The system can print most paper clinical forms with bar code headers automatically or on an ad hoc basis, and forms can be viewed on-line after completion and scanning.

The other substantial business need for the organization was automated billing capability; this is the third strategy to reduce organizational expense. Because of the development of products other than prepaid health care and improvement in collections that involved outside payers (e.g., third-party payers, coordination of benefits, or retroactive insurance terminations), the MARS database was given the capability to collect a data set for billing. This involves the collection of procedure information; International Classification of Diseases, ninth revision, diagnostic codes; and visit-intensity common proce-

dures terminology (CPT) codes. Diagnostic codes come from the medical coders who use GMIS Autocoder (GMIS, Malvern, Pennsylvania). The CPT codes are collected automatically by using the optical mark sense forms (Figure 3). With this system, the organization was able to eliminate the need for medical abstracters, who used to code the 4% of the visits appropriate for billing at a cost of \$400,000 per year (an amount that would have increased as the organization developed more billable products). A summary of the MARS cost-benefit analysis is shown in Table 3.

## Conclusions

Reminders generated by an electronic medical record system improve compliance with guidelines. Computer-generated reminders can support quality improvement programs that would be impossible to implement by conventional means. For example, Kaiser Permanente of Ohio has been able to stratify its diabetic population into levels of amputation risk and its pediatric and adult asthma population into levels of asthma severity. This type of stratification allows interventions to be targeted to the patients who are most likely to benefit from them. Improvement in the quality of care also

TABLE 1

## Quality Enhancements Supported by the Medical Automated Record System\*

CATEGORY	INTERVENTION	DESCRIPTION	EFFECT
Improved care in CAD	Aspirin	Reminder at the time of a visit if a CAD patient is not taking aspirin	Guideline compliance increased from 56% to 82% in 27 months
	Lipid lowering	Reminder at the time of a visit that a CAD patient has a low-density-lipoprotein cholesterol level greater than 100 mg%	Guideline compliance increased from 10% to 20% in 7 months
Improved care in CHF	ACE inhibitors	Reminder that a patient being seen has CHF but is not receiving an ACE inhibitor	Guideline compliance increased from 54% to 66% in 24 months
Improved care in diabetes mellitus	Stratification	Reminder, when a diabetic patient is being seen, to stratify for risk for amputation	76% of the diabetic population was stratified for risk for amputation in 26 months
	Referral of medium- and high-risk diabetic patients to the podiatry department	Automatic tracking for a podiatry referral of patients determined to be at medium- or high-risk for amputation	Percentage of medium- and high-risk diabetic patients who had seen a podiatrist increased from 14% to 66% in 19 months
Improved care in hypertension	Recommended antihypertensive medications	Reminder that a patient is hypertensive, has no comorbid conditions, and is receiving a calcium-channel blocker without receiving both diuretics and $\beta$ -blockers	Percentage of hypertensive patients taking nonrecommended medications decreased from 16% to 12% in 12 months
	Hypertensive follow-up	Report of hypertensive patients with diastolic pressure $\geq 105$ mm Hg who have not been seen in 2 months  Automated letter to hypertensive patients not seen in primary care in 1 year	500 patients are listed every month  500 letters are mailed each month
Improved care in asthma	Stratification	Reminder that an asthmatic patient being seen has not been stratified to severity level	65% of adult patients were stratified in 29 months
	Anti-inflammatory inhalers	Reminder that a moderate or severe asthmatic patient being seen has not been prescribed an anti-inflammatory inhaler	Initial assessment found that 86% of moderate and severe adult asthmatic patients had been prescribed an anti-inflammatory inhaler
	Improve patient compliance with anti-inflammatory inhaler use	Reminder that a moderate or severe asthmatic patient being seen has had fewer than 4 inhalers dispensed in the past 6 months	Activated in August 1997
Preventive health care	Influenza vaccination	Reminder that a patient being seen needs an influenza vaccination because of age older than 64 years or a predisposing condition	Percentage of patients older than 64 years of age who were offered an influenza vaccination during a primary care visit increased from 56% to 69% in 36 months
	Smoking cessation program analysis	Quarterly batch reports to primary care physicians and facility administrators that display compliance with the various elements of the smoking cessation program	Smoking prevalence in the region has decreased by 3 percentage points (12%) in 18 months

\*ACE = angiotensin-converting enzyme; CAD = coronary artery disease; CHF = congestive heart failure.

results from the reliable availability of clinical data even at sites distant from the chart, such as emergency departments.

Kaiser Permanente of Ohio's MARS database has also satisfied the organization's business goals. The sys-

tem reduced the need for an extensive chart delivery system and is reducing organizational expense. It allows the automatic generation of bills, which simplifies billing for business products and thus encourages development of new products.

**TABLE 2**

**Influenza Vaccination, by Year, in Kaiser Permanente Members 65 Years of Age or Older**

VARIABLE	1992	1993	1994	1995	1996	1997
	%					
Offered influenza vaccination during an office visit	56	66	66	69	69	73
Immunized against influenza within the organization	48	53	53	55	59	64
Immunized against influenza outside the organization	—	—	—	11	11*	11*
Total	—	—	—	66	70*	75*

\*Estimated percentage.

An organization that wishes to implement an automated medical record system must recognize the many internal customers for such a system, as well as the financial and workflow constraints in building the system. If this is done, systems can be created that handle

the organization's business needs and allow practitioners to improve the quality of care delivered without decreasing productivity.

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**TABLE 3**

**Annual Savings and Expenses from Use of Electronic Medical Records**

VARIABLE	AMOUNT, \$
<b>Savings</b>	
Medical record room and support staff	2,800,000
MARS* generation of clinical forms	500,000
MARS generation of billing data	400,000
<b>Total</b>	<b>3,700,000</b>
<b>Expenses</b>	
Personnel	600,000
Printing	200,000
Network expenses	150,000
Memory	200,000
License renewals	80,000
<b>Total</b>	<b>1,230,000</b>
<b>Total savings</b>	<b>2,470,000</b>

\*MARS = medical automated record system.