SPECIAL EDITOR
Edward H. Wagner, MD, MPH

DAVID K. MCCULLOCH, MD
Diabetologist

MARTHA J. PRICE, DNSc
Diabetes Nurse Consultant

MIKE HINDMARSH, MA
Clinical Improvement Coordinator

EDWARD H. WAGNER, MD, MPH
Director, MacColl Institute for Healthcare Innovation

Group Health Cooperative of Puget Sound
Seattle, Wash

Effective Clinical Practice. 1998;1:12-22.

A Population-Based Approach to Diabetes Management in a Primary Care Setting:

Early Results and Lessons Learned

OBJECTIVE. To determine the effect of a multifaceted program of support on the ability of primary care teams to deliver population-based diabetes care.

DESIGN. Ongoing evaluation of a population-based intervention.

SETTING/PARTICIPANTS. Group Health Cooperative of Puget Sound, a staff model HMO in which more than 200 primary care providers treat approximately 15 000 diabetic patients.

INTERVENTION. A program of support to improve the ability of primary care teams to deliver population-based diabetes care was implemented. The elements of the program are based on an integrated model of well-validated components of delivery of effective care to chronically ill populations. These elements have been introduced since the beginning of 1995, and some aspects of the program were pilot-tested in a few practice sites before being implemented throughout the organization. The program elements include 1) a continually updated on-line registry of diabetic patients; 2) evidence-based guidelines on retinal screening, foot care, screening for microalbuminuria, and glycemic management; 3) improved support for patient self-management; 4) practice redesign to encourage group visits for diabetic patients in the primary care setting; and 5) decentralized expertise through a diabetes expert care team (a diabetologist and a nurse certified diabetes educator) seeing patients jointly with primary care teams.

MAIN OUTCOME MEASURES. Patient and provider satisfaction through existing system-wide measurement processes; process measures, health outcomes, and costs are tracked continuously.

RESULTS. Patient and provider satisfaction have improved steadily. Interest in and use of the electronic Diabetes Registry have grown considerably. Rates of retinal eye screening, documented foot examinations, and testing for microalbuminuria and hemoglobin A_{1c} have increased substantially.

CONCLUSIONS. Providing support to primary care teams in several key areas has made a population-based approach to diabetes care a practical reality in the setting of a staff model HMO. It may be an important mechanism for improving standards of care for many diabetic patients.

Traditional medical practice is organized to respond quickly to acute patient problems, but it does not adequately serve the needs of persons with chronic illnesses, such as diabetes (1). More than 90% of diabetic patients receive their care from primary care providers who may not have a special interest in or up-to-date information on diabetes and who see diabetic patients in the course of busy days filled with patient-generated visits for specific problems, most of which are not related to diabetes.

Specialist physicians have been shown to be more knowledgeable about efficacious interventions for some major chronic illnesses, may adopt new approaches more quickly (2, 3), and produce better outcomes in hospital settings (4–6). When diabetic patients see

specialists in the context of organized programs, such as hospital-based clinics, outcomes are improved (6–8). However, it is difficult to tell how much of the improvement is due to expert knowledge and how much is due to the systematic and organized approach to care. Indeed, in the Medical Outcomes Study (9), which compared outpatient management of type 2 diabetes and hypertension by family practitioners, general internists, and specialists, few significant differences were seen. It could be argued that the main conclusion of the Medical Outcomes Study is that the management of these chronic illnesses was poor in all settings, reflecting the lack of a well-organized, systematic approach to care.

When the management of diabetic patients by generalists and endocrinologists was compared at a large Veterans Affairs Medical Center (10), some interesting observations were made. Although diabetic patients seen in the diabetes clinic were somewhat more likely to receive appropriate routine care for diabetes, such as foot examinations or testing for hemoglobin A_{1c} (HbA_{1c}), they were less likely to receive routine care that was not directly related to diabetes (such as inquiries about cardiac symptoms). Less than 75% of diabetic patients were receiving the "minimally acceptable" standard of care, even in the specialty clinic. This result may reflect the lack of a systematic, organized approach to care.

Several approaches have been tried to improve the care of diabetic patients in primary care settings. These include the use of "diabetes mini-clinics" within primary care practices (11, 12), the encouragement of better organization of patient education (13, 14), and case management by nurse specialists under the supervision of diabetologists (15). We have developed a multifaceted approach to the improvement of diabetes care at Group Health Cooperative of Puget Sound (GHC); this approach enhances the primary care provider's ability to deliver diabetes care in a planned, population-based manner (16, 17). It is based on a model and incorporates well-validated concepts for the delivery of care and self-management support to persons with chronic illness (1, 16). In this paper, we report an evaluation of the first 3 years of this program and document the improvements and problems encountered.

Methods

Setting

Group Health Cooperative of Puget Sound is a not-for-profit HMO that serves more than 400 000 enrollees in western Washington State. These enrollees include approximately 15 000 diabetic patients, who are cared for by more than 200 primary care providers practicing in 25 clinics around Puget Sound. Two endocrinologists serve this population: One has a traditional consultative role in a GHC specialty clinic, and the other has the population-based role described below.

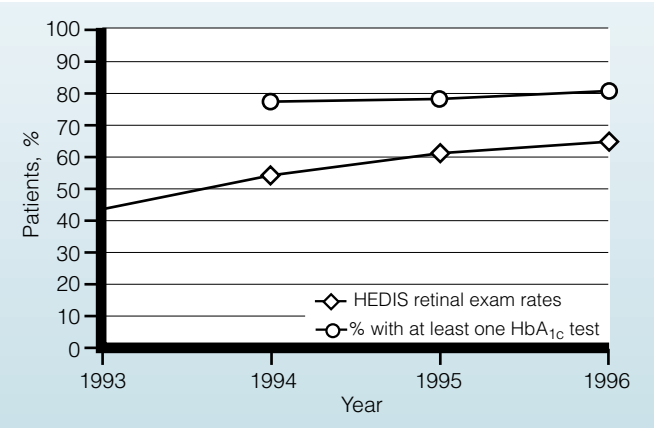

FIGURE 1. Rates of dilated retinal examinations (*diamonds*) and hemoglobin A_{1c} (HbA_{1c}) testing (*circles*) among diabetic patients at Group Health Cooperative of Puget Sound since 1993. HEDIS = Health Plan Employer Data Information Set.

Program Design

The diabetes improvement program at GHC, called the Diabetes Roadmap, was initiated in 1994, and the first intervention components were introduced into the GHC delivery system early in 1995. The Roadmap is a comprehensive, centrally coordinated effort to improve the outcomes (health status, clinical status, patient satisfaction, and cost) of all diabetic patients seen at GHC. Specific intermediate targeted outcomes include increased rates of retinal screening, increased performance and documentation of foot inspection and risk-related education, increased testing for microalbuminuria, increased testing for HbA_{1c}, reduced HbA_{1c} levels, and improved patient satisfaction. We developed measurement approaches for each of these outcomes. Except for the approach to patient and provider satisfaction, all approaches rely on automated data collated in the Diabetes Registry.

The theoretical and evidence base for the design of the Roadmap has been described elsewhere (1, 16). It was derived from an analysis of successful interventions for chronic disease and is summarized in Figure 1. Central to improved outcomes are regular, productive interactions between an empowered patient and a prepared provider team and interactions in which the clinical and self-management needs of the diabetic patient are met. For productive interactions to occur, practice systems must ensure that provider teams have requisite expertise, appropriate patient information, and organized clinical practice support and that patients have ready access to self-management support resources.

Clinical Information Systems: The Diabetes Registry

All primary care providers at GHC have computer workstations in their offices (Compaq 486 PCs) that are linked

to the administrative, pharmacy, and laboratory databases of GHC. All patients who enroll at GHC choose a primary care provider, and patients with diabetes are identified from administrative databases by pharmacy (prescriptions for insulin or diabetes medications), laboratory (elevated fasting or random blood glucose levels or elevated HbA_{1c} levels), or hospital discharge data (International Classification of Diseases, ninth revision [ICD-9] codes for diabetes mellitus). Utilization and laboratory data are added regularly to keep this registry database current.

Since 1995, each primary care provider has been given a quarterly written summary, in the form of a printed spreadsheet, of the diabetic patients under her or his care. This summary shows the dates and results of routine assessments, such as dilated retinal examinations and measurement of serum creatinine, lipid, and HbA_{1c} levels (Table 1). Since May 1996, providers have been able to access this information at their computer workstations through the regularly updated, on-line Diabetes Registry. Laboratory and pharmacy data are updated daily. Information about the dates of dilated retinal examinations is entered from the Appointments and Registration database once a month, but updates will soon be done more frequently. The results of retinal examinations are entered directly by optometry and ophthalmology staff members. Primary care teams are encouraged to enter the results of foot examinations, vital sign assessment (smoking status, blood pressure, height, and weight), and patient education interactions into their workstation by using simple, standardized data entry screens. The registry database provided most of the evaluative information for this paper.

In addition to giving primary care providers information about their diabetic patients in the form of a spreadsheet, the registry can also print out a summary for a particular patient; this can serve as a reminder of the elements of care that should be addressed for that patient. This summary includes a prioritized list of all elements of care that the diabetic patient should receive (Figure 2).

Delivery System Design: The Planned Diabetes Visit and Chronic Care Clinic

Evidence from GHC and elsewhere suggests that it is difficult to meet the complex needs of a diabetic patient in a typical 10- to 20-minute primary care visit for which only minimal preparation is possible. We have implemented two related innovations in the organization of care for diabetic patients: the planned diabetes visit, as modeled in joint visits with the diabetes expert team (see The Diabetes Expert System), and the chronic care clinic.

The chronic care clinic, derived from the concept of the British mini-clinic (11, 12), is a regular half-day session in a primary care physician's practice that is devoted to the care of 6 to 10 diabetic patients. Patients are invited in groups for clinic appointments. Each patient receives a

TABLE 1
Data Elements Captured on the Diabetes Registry

CATEGORY	DATA ELEMENTS	SOURCE
Demographic elements	Name, sex, address, telephone number, ID date*, ID source†, consumer number	Administrative database
Vital signs	Smoking status, height, weight, blood pressure	Vital statistics data entry screen
Cardiac elements	Aspirin use and levels of cholesterol, low-density lipoprotein cholesterol, high-density lipoprotein cholesterol, and triglycerides	Pharmacy and laboratory databases
Renal elements	Angiotensin-converting enzyme inhibitor use, serum creatinine level, urinary microalbumin–to–urinary creatinine ratio	Pharmacy and laboratory databases
Eye examination	Date and results of most recent dilated retinal examination	Administrative database and eye data entry screen
Foot care	Date and results of most recent foot examination	Foot care data entry screen
Glycemic control	Hemoglobin A_{1c} level; oral hypoglycemic agents or insulin regimen	Pharmacy and laboratory databases
Patient education	Date of initiation of each element of self-management or behavioral change	Patient education data entry screen
Service utilization	Outpatient visits, hospitalizations, telephone contacts	Administrative database

**Date on which the person was identified as having diabetes.*
†Source that identified the person as having diabetes (such as laboratory database or pharmacy database).

systematic assessment, a pharmacist's evaluation of his or her drug regimen, interaction with a nurse with regard to self-management needs, and a private physician visit he or she then attends a facilitated group session. The chronic care clinic is currently being evaluated in a randomized trial; data are not yet available. Both the planned diabetes clinic and the primary care clinic emphasize the importance of practice team preparation for a visit; this preparation should include collecting and assembling relevant data, developing and maintaining a treatment plan that emphasizes the prevention of complications of diabetes, and discussing and revising the treatment and self-management plan with the patient.

Decision Support: Evidence-Based Clinical Guidelines

To ensure that practices have the requisite expertise to manage diabetes, formal guidelines serve as the foundation for our approach. The approach we use to develop and implement evidence-based guidelines at GHC is described elsewhere (18, 19). Guidelines for retinal screening, foot care, screening for microalbuminuria, and glycemic management have been developed and implemented.

Retinal Screening: The retinal screening guideline was introduced in March 1995. All patients with type 2 diabetes must have a dilated retinal examination annually from the time of diagnosis, and all patients with type 1

Group Health Cooperative of Puget Sound
Patient Summary Sheet

Date: 1/10/97
Consumer # **00000188**
Patient Name: **Brown, Betty**
Patient Age: **65**
Primary Practitioner: Payne, Thomas

Primary Phone #:
Alternate Phone #:

Clinical Roadmap Populations
Diabetes, Secondary Prevention Heart Care

Identified Risk Factors and Reminders for this Patient

1. Heart Care Reminders

Patient received:
An Active Partnership for Your Heart? *If not contact resource line at (8-320) 448-6448 or 1-800-992-2279*

Capture aspirin use status on the registry.

No baseline LDL on record.
Capture baseline LDL by investigation of chart for past fasting lipid profiles while patient was not on a medication.
For ideal baseline measure average two fasting lipid profiles. Program will suggest lipid therapy based on goals of therapy of (LDL < 100) or (LDL < 130 and TC/HDL ratio <4) and will ignore 30% reduction in LDL as goal of therapy until baseline LDL entered.

Patient has not yet achieved lipid lowering goals suggested by the secondary prevention guideline.
Consider increasing dosage of current medication of changing to a more powerful medication to lower LDL.
Goals of therapy are
30% reduction from baseline LDL (if baseline entered) or LDL <130 and TC/HDL ratio <4

2. Kidney Risks

>50 mcg, suggest ACE Inhibitor per Microalbuminuria Guideline
Creatinine > 1.5

3. Retinal Screening

Due for Retinal Screening Exam
Retinal changes present: Right eye status: BDR Left eye status: BDR

4. Foot Risk Status

High Risk Foot, initiate prophylactic intervention program per Diabetic Foot Screening guideline and encourage patient to sign prophylactic foot care contract

5. Glycemic Control

HbA_{1c} > 8.0, refer to Glycemic Control Guideline
BMI > 27.0

FIGURE 2. **Sample patient summary from the Diabetes Registry. ACE = angiotensin-converting enzyme; BDR = background diabetic retinopathy; BMI = body mass index; HbA_{1c} = hemoglobin A_{1c}; HDL = high-density lipoprotein; LDL = low-density lipoprotein; TC = total cholesterol.**

diabetes must have this examination annually beginning 5 years after diagnosis. The examinations are done by optometrists who are trained and supervised by ophthalmologists at several GHC sites. The responsibility for the eye appointments remains with the optometry departments, but the primary care teams influence the program by tracking patients from the Diabetes Registry and encouraging them to make eye appointments.

Foot Care: The foot care guideline was introduced in August 1995. All patients with type 2 diabetes have a foot screening examination annually from the time of diagnosis, and all patients with type 1 diabetes should have this examination annually beginning 5 years after diagnosis. The purpose of this examination is to identify persons at high risk for developing foot ulcers in the next few years because of neuropathy, deformities, or peripheral vascular disease (20, 21). Examination identifies the presence or absence of foot deformities, excessive callus, or bunions and uses the Semmes–Weinstein 5.07 monofilament (21) to test cutaneous pressure sensitivity. Patients found to be at high risk are taught protective foot care behavior through the use of patient contracts (22). This guideline also provides advice on the management of established foot ulcers. The Diabetes Registry is used to maintain tracking of patients who have had foot examinations, those who are overdue for examinations, and those who are at high risk for foot problems. A simple data entry screen allows input of the five essential data elements.

Screening for Microalbuminuria: The microalbuminuria guideline was introduced in November 1996. All diabetic patients 12 to 70 years of age who are not already receiving an angiotensin-converting enzyme inhibitor have the urinary microalbumin–to–urinary creatinine ratio measured in a random urine sample on an annual basis. If the result is positive on two occasions, the patient should start receiving lisinopril and build up to 10 mg daily.

In addition, patients who smoke are counseled vigorously about smoking cessation (23) and patients receive advice on cardiac risk reduction (24, 25) and are supported in their efforts to achieve an HbA_{1c} level less than 7% (25). The Diabetes Registry is automatically updated when patients are tested for microalbuminuria, and it allows the easy identification of patients who have not been tested or are overdue for testing.

Glycemic Management: A guideline suggesting how and when to use diet, exercise, oral hypoglycemic agents, and insulin was introduced in July 1997. This guideline will help primary care providers and their diabetic patients make joint, evidence-based decisions about an appropriate target HbA_{1c} level and a rational and acceptable method for achieving that level. It includes detailed support for both patient and provider about intensive insulin therapy for appropriate patients, and it is linked to patient self-management support material and other resources.

In addition to the diabetes-specific guidelines discussed above, several other GHC guidelines have had a positive effect on diabetic patients. Most notable are guidelines for the prevention of coronary heart disease and for adult immunization; these guidelines contain specific advice and targets for diabetic patients.

Decision Support: The Diabetes Expert System

The Diabetes Expert System supports the implementation of guideline use and other interventions through two layers of support for primary care teams.

The Diabetes Expert Team: To support our population-based approach to improving diabetes care, we created an expert diabetes team consisting of a diabetologist and a nurse certified diabetes educator. Rather than see patients in a specialty center on a referral basis, the team travels to each of the 25 primary care clinics several times each year to make joint visits with the primary care teams (which consist of any combination of a physician, a nurse, and a physician's assistant or nurse practitioner). Each visit lasts approximately 30 to 40 minutes, during which the patient (possibly with family members), the primary care team, and the diabetes expert team meet together. In a typical day, the diabetes expert team sees two or three patients with each of three to six primary care teams. This delivery design is intended to 1) give appropriate advice for the individual patients seen; 2) model, for the primary care team, ways to set priorities with patients and organize effective planned visits; 3) address patients' specific concerns and ensure that routine aspects of care (such as foot examinations, eye examinations, and HbA_{1c} testing) are done; 4) demonstrate, to the primary care team, efficient ways to examine the feet, interpret the results of blood glucose self-monitoring, and manage important issues, such as cardiac risk reduction and changes in behavior related to diet and exercise; 5) reinforce other aspects of the diabetes improvement efforts (such as use of the Diabetes Registry, evidence-based guidelines, patient education materials, and planned group visits); and 6) answer general questions about diabetes from both patients and the primary care teams.

Practices also have the option to refer diabetic patients for traditional specialty consultation.

Nursing Involvement in Population-Based Management: New nursing functions have been approved at several of the clinical practice sites where a registered nurse who is also a certified diabetes educator is supported with the time and resources to provide local expertise and help the primary care teams implement Roadmap interventions. The registered nurse contributes to the primary care teams' development of a population-based management approach that reaches all diabetic patients, not just those who initiate visits for an episode of illness. The registered nurse helps primary care teams use the Diabetes Registry to organize care,

redesign clinic activities to accommodate planned diabetes visits or chronic care clinics, implement self-management support activities, and coordinate care with other delivery settings. This person is also involved in shaping patient education and self-management follow-up care.

Decision Support: Guideline Implementation

Several techniques are used to assist in the implementation of guidelines (19).

Classic Continuing Medical Education: In the past 3 years, we have held 10 large continuing medical education courses for GHC clinical providers (those with MD, RN, LPN, or MA degrees); these courses have included lectures and workshops on diabetes. Three courses specifically discussed retinal screening, 6 discussed foot care, 4 discussed screening for microalbuminuria, and 8 discussed glycemic management.

Individual and Very Small Group Continuing Medical Education: Evidence-based diabetes guidelines were featured prominently in medical staff lunchtime courses given by the diabetes expert team at the 25 clinics throughout the year.

Feedback: Information about which of a provider's diabetic patients have had appropriate screening and management has been available from the Diabetes Registry since May 1996. Individual providers can see statistical displays of their rate of screening for various diabetes measures compared with the mean for their clinic and for GHC as a whole. In addition, providers receive quarterly clinical practice reports that include the rate of dilated retinal examinations for their diabetic patients. In the summer of 1997, rates of foot care examinations, testing for microalbuminuria, and HbA_{1c} testing were added to the clinical practice report.

Expert Coaching: The diabetes expert team offers support and advice during joint patient visits.

Clinical Decision Support for Physicians: The guidelines are available both in print and on-line at every clinical computer workstation.

Patient-Specific Decision Support: Specific patient education materials exist for each guideline requiring patient self-management activities (for example, there is a patient contract for protective foot care behavior for patients with "high-risk feet"). Detailed patient education notebooks have been written and made available at no cost to diabetic patients since May 1997. These notebooks contain comprehensive self-management support covering all aspects of diabetes care.

Patient Self-Management Support

Our approach to diabetes self-management support and its theoretical and empirical underpinnings are detailed elsewhere (26). The collaborative aspects of self-management support (priority setting, treatment planning, problem solving, and follow-up) are provided by the primary care team, usually by the practice nurse. This collaboration is supported by written education materials (called *Right Track*) that are intended to both provide information and address the patient's stage of readiness to be actively involved in self-management behaviors. The materials are provided in a three-ring binder so that the information can be customized for each patient and linked directly to his or her treatment plan. The notebook is available to the patient only through a pharmacy prescription from the primary physician or nurse; this method of distribution allows us to track notebooks through the pharmacy's automated system. Furthermore, the dispensing of a notebook is noted in the Diabetes Registry, and this activates the patient's diabetes education screen. It is on this screen that all self-management instruction encounters (date of encounter, content of encounter, and patient's stage of readiness for self-management) are electronically tracked.

Evaluation of the Impact of the Program

The effect of the Roadmap on the use of HbA_{1c} testing, retinal screening, foot care, and screening for microalbuminuria was evaluated by examining temporal trends in the indicators over the period before and after guideline implementation. For all areas except foot care, the data were derived from GHC administrative systems (utilization and laboratory). Foot care was assessed by completion of the foot evaluation screen in the Diabetes Registry. For all indicators except retinal screening, the denominator was the number of diabetic patients who met Diabetes Registry entry criteria in a specific period. For retinal screening, we used the numerator and denominator definitions of HEDIS [Health Plan Employer Data Information Set] 3.0.

The prevalence of smoking among diabetic patients in GHC was assessed by an annual survey of randomly sampled diabetic patients. Provider satisfaction with diabetes care resources was assessed in 1992 in a random sample of 80 GHC primary care physicians as part of the type 2 diabetes Patient Outcomes Research Team (PORT). A subset of these items was administered in 1996 to 60 randomly chosen primary care physicians.

The effect of the diabetes expert team was assessed by comparing the performance over time of a random sample of primary care practices that had joint patient visits with the diabetes expert team in 1995 with that of a sample of 30 practices that did not have joint visits. The opportunity to meet with the diabetes expert team was communicated to all GHC clinics through letters, voice mail messages, e-mail messages, and clinic leaders, but participation was voluntary. From January 1995 through April 1997, the diabetes expert team made 183 joint visits at the primary care clinical practice sites; these visits involved 227 primary care providers and 804 diabetic patients.

TABLE 2

Primary Care Physicians Who Rated Diabetes Care Resources at Group Health Cooperative of Puget Sound as Excellent or Very Good in 1992 and 1996

RESOURCE	1992	1996
	%	
Access to retinal screening	66	86
Access to CDEs*	41	52
Guidelines	16	62
Access to clinical expertise	48	58

**CDEs = certified diabetes educators.*

From all primary care practices that made joint visits with the diabetes expert team in 1995 and had at least 20 diabetic patients in their care, we randomly chose 30 (group A). We also chose 30 primary care practices that had not made joint visits with the diabetes expert team (group B). The practices in the two groups were similar in size and had delivered a similar level of diabetes care (according to their 1994 rates of dilated eye examinations, HbA_{1c} testing, and other variables) before the Roadmap interventions. Table 2 shows the baseline information on the 60 practices. We compared groups A and B in calendar year 1996 with respect to various measures of clinical care.

The comparisons within groups from 1994 to 1996 were done by using the Wilcoxon rank-sign test; comparisons between groups A and B were done by using the Mann–Whitney U-test. Results are expressed as the mean ± SE.

Results

Figure 1 shows the period prevalence of HbA_{1c} testing (at least one measure) and dilated retinal examinations by at least one eye care provider in the year before implementation of the Roadmap (1994) and the 2 years after implementation. The prevalence of HbA_{1c} testing was approximately 77% in 1994 before implementation of the Roadmap, but it had steadily increased to 80% by 1996. Retinal screening rates were first computed for HEDIS in 1993 at 46%; this placed GHC among the lowest of the original HEDIS test organizations. Since that time, these rates have increased steadily. By 1996, almost two thirds of diabetic patients in GHC were receiving annual dilated retinal examinations from an eye care provider.

Until the implementation of the Diabetes Registry in May 1996, there was no way (short of patient survey or chart audit) to determine whether a diabetic patient was receiving foot examinations or foot care education. The GHC foot care guideline recommends beginning with a standardized evaluation of risk for foot lesions. Figure 3 shows the cumulative percentage of diabetic patients in GHC who had a foot evaluation recorded in the Diabetes Registry. In just over 1 year, 50% of all diabetic patients had a recorded foot examination with findings. Because 20% of physicians have never logged on to the Registry but may have had foot examinations, 50% is probably an underestimate. Patient surveys and chart reviews done before May 1996 indicate that less than 20% of patients were receiving systematic foot care.

Although the microalbuminuria guidelines were not formally implemented until November 1996, the Roadmap and the diabetes expert team were recommending screening before that time. Because of Roadmap efforts, the test for the urinary microalbumin–to–urinary creatinine ratio was made available by the GHC laboratory in March 1996. Figure 4 shows that the number of urinary microalbumin tests ordered increased rapidly once this test was offered within GHC.

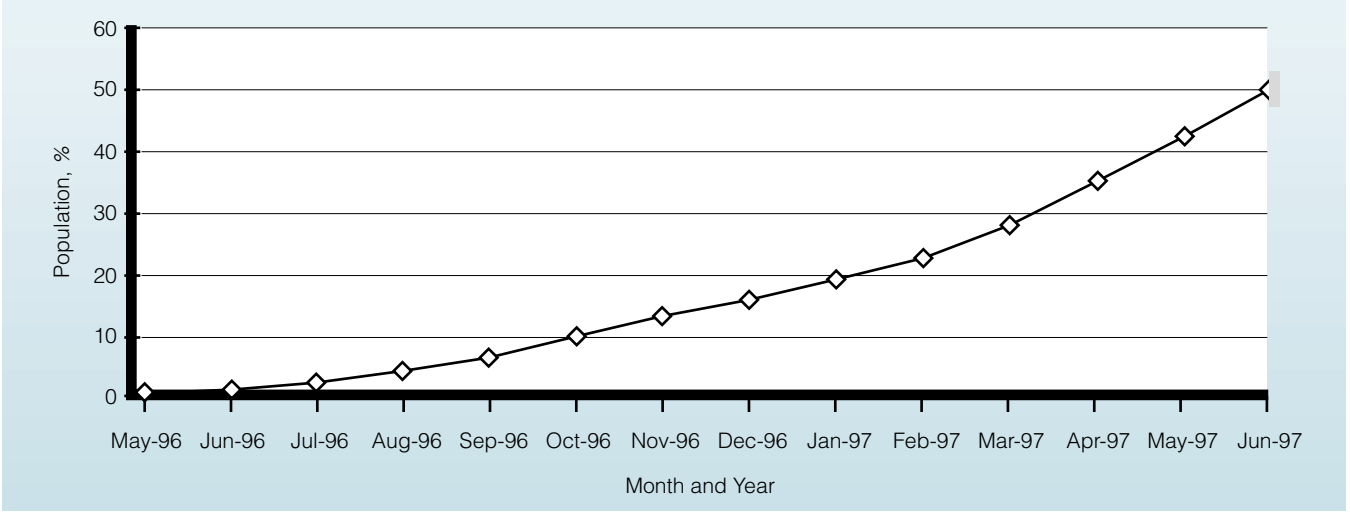

FIGURE 3. **Cumulative percentage of the diabetic population that has had foot examinations since May 1996.**

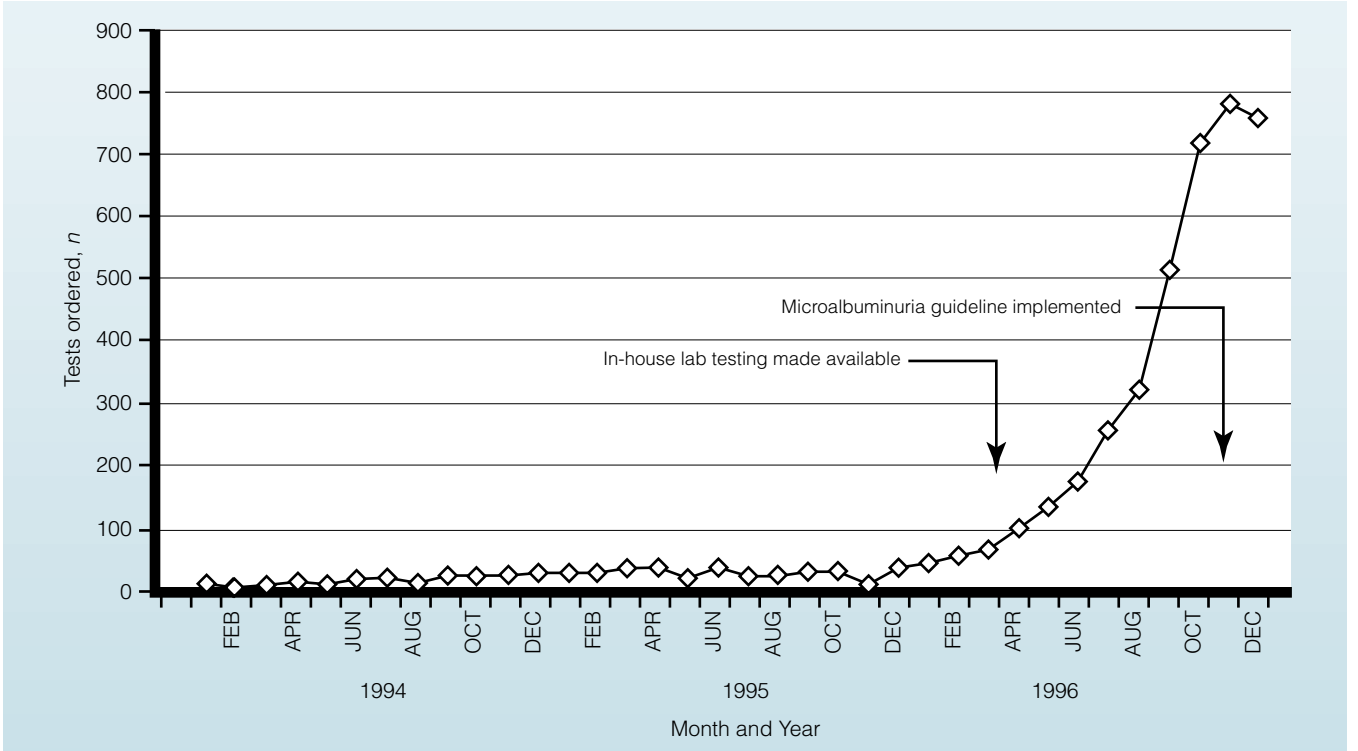

FIGURE 4. Monthly number of microalbuminuria tests ordered for diabetic patients since 1994.

An important element of the GHC Roadmap program is smoking prevention and cessation. This is especially critical in the diabetic population, which has a substantially increased risk for coronary heart disease. The identification and alleviation of risk factors for coronary heart disease are a primary objective of the Roadmap. Figure 5 shows the self-reported prevalence of cigarette smoking among surveyed diabetic patients before and after initiation of the Roadmap. The prevalence of smoking decreased from 14% in 1994 to 10% in 1996.

The effect of the diabetes expert team was assessed by comparing the diabetes practice activities of the two random samples of GHC primary care practices: group A, which was visited by the diabetes expert team during 1995, and group B, which did not request a visit. The two samples did not significantly differ at baseline (1994) in number of diabetic patients or in mean rates of dilated retinal examinations or glycohemoglobin testing. Rates of dilated retinal examinations among group A practices increased from 52.4% ± 1.6% in 1994 to 57.5% ± 2.0% in 1996, whereas rates in group B practices were unchanged (51.8% ± 2.0% to 48.2% ± 1.5%). The differences between groups A and B in 1996 were significant ($P < 0.001$). The percentage of patients who had at least one glycohemoglobin test rose from 78.5% ± 1.7% in 1994 to 85.8% ± 2.8% in 1996 in group A but remained unchanged in group B (81.6% ± 1.4% in 1994 to 77.3% ± 2.5% in 1996). The differences between groups A and B in 1996 were significant ($P < 0.03$). The mean HbA_{1c} level for diabetic patients in 1996 was 7.7% ± 0.01% for group A and 7.8% ± 0.01% for group B; the difference was not significant.

No 1994 data are available for foot care examinations (the Diabetes Registry was not available until 1996) or microalbuminuria screening (this test was not done in GHC laboratories until 1996). In 1996, the rate of documented foot examinations was more than threefold higher in group A (34.2% ± 3.3%) than in group B (10.9% ± 1.7%) ($P < 0.001$). Similar results were seen for microalbuminuria screening (29.6% ± 2.8% compared with 9.3% ± 1.9%; $P < 0.001$). Group A providers were also much more likely to have used the Diabetes Registry (8.4 ± 2.1 times compared with 1.5 ± 0.4 times; $P < 0.001$).

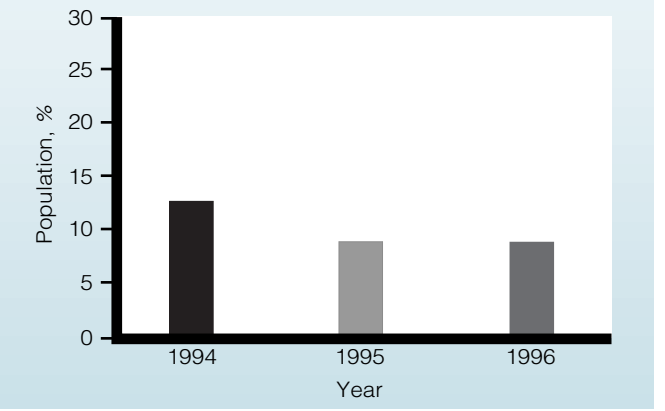

FIGURE 5. Prevalence of smoking among the diabetic population at Group Health Cooperative of Puget Sound from 1994 to 1996.

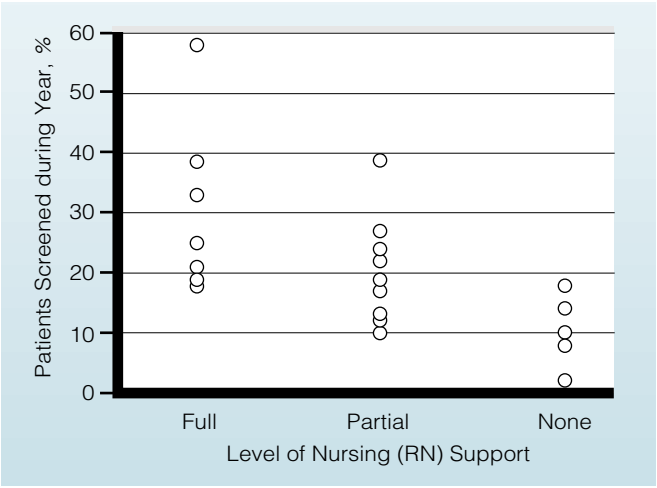

FIGURE 6. **Rates of screening for microalbuminuria at clinic sites that have a fully supported, population-based nursing role; a partially supported role; or no population-based nursing. Circles represent area medical centers.**

Table 2 shows the percentage of randomly sampled primary care physicians who rated various diabetes-related resources as very good or excellent in 1992 and 1996. The percentage of physicians rating all four resources as excellent or very good increased significantly after the implementation of Roadmap interventions.

To assess the effect of the expert role of the local registered nurse or RN certified diabetes educator, we compared rates of microalbuminuria screening among three groups of clinics: those with an active registered nurse or RN certified diabetes educator (full support), those with partial support by a registered nurse or RN certified diabetes educator, and those without this support. Figure 6 shows that the amount of support was directly related to guideline compliance.

Discussion

Our work shows that a multifaceted program of support for primary care teams can positively influence the care of many diabetic patients by taking an organized, efficient population-based approach to patients at the primary care practice site. We have demonstrated that diabetes care at GHC changed in accordance with evidence-based guidelines after the implementation of a coordinated set of system changes.

Before generalized interpretations and extrapolations are made from our work, some of its limitations must be recognized. This study was not set up as a randomized, controlled clinical trial. The Roadmap was gradually implemented over a 3-year period; data on process measures, outcomes, and provider satisfaction were collected before and throughout implementation. Therefore, we cannot be certain that the improvements seen were the results of our activities as opposed to larger secular influences, such as publicity generated by the national debates on health care reform or the initiation of HEDIS reporting. Also, because we implemented several interrelated components of the program simultaneously, it is difficult to ascribe particular improvements to particular interventions. However, some temporal trends were seen. The retinal screening guideline was the first guideline to be implemented, and rates have risen steadily since then. In contrast, rates of screening for microalbuminuria remained low in 1994 and 1995 despite considerable national press coverage about the merits of screening and the benefits of angiotensin-converting enzyme inhibitors. Rates of screening for microalbuminuria began rising early in 1996 when we made the assay readily available, at low cost, in the GHC laboratory; these rates climbed steeply after the evidence-based guideline was implemented later that year.

It is difficult to know how beneficial a program such as ours would be in other clinical settings. We have implemented it in a staff model HMO where we have easy access to pharmacy, laboratory, and administrative data and where all patients under the care of each primary care provider are GHC enrollees. For providers practicing in an independent provider organization or fee-for-service setting, implementation will be harder. However, the principles of a population-based approach that uses explicit evidence-based guidelines and takes diabetes expertise out to primary care sites could be implemented in most settings. At GHC, we have a growing network of contracted providers for whom only some patients are GHC enrollees. We have recently begun implementing aspects of the program with these providers and are already seeing some improved outcomes. The most difficult aspect of the program to replicate outside of the staff model structure is the on-line, continually updated Diabetes Registry, but simple alternatives (such as card files or spreadsheets) could be used to provide a population-based approach to diabetes care.

The order in which we implemented the components of the program was determined by a variety of clinical, practical, and political factors. From the outset, we communicated the vision of the overall program throughout GHC but made it clear that implementing all aspects would take time. Visits by the diabetes expert team began immediately in 1995. Developing the patient education material and programming for the Diabetes Registry took several months. Because of the rigorous approach used to create each guideline (18, 19), guidelines were done sequentially. Because the HEDIS reports in 1993 highlighted a major deficiency in diabetic retinal screening practices, this area was targeted first. The foot care guideline was the second one implemented because we felt that the gap between current and ideal practice

was large and that the potential for simultaneously improving outcomes and reducing costs was great (27). Microalbuminuria screening was added next, and the guideline on glycemic control was delayed until 1997.

Although the importance of improving blood glucose levels in the diabetic population was acknowledged and promoted, we emphasized cardiac risk reduction and the management of diabetic complications in the first 3 years of our program. These are areas of diabetes management that we felt could be handled well in a primary care setting if a systematic, organized approach was taken. We wanted to establish effective new systems of care for diabetes management in the primary care teams before adding the expectation of a more consistent and intensive approach toward the improvement of glycemic control. This expectation has been added in the past few months, and we expect that rates of HbA_{1c} testing and mean HbA_{1c} levels will improve over the next few years.

One of the most unusual aspects of our program was having the diabetes expert team travel to all of the primary care sites on a regular, ongoing basis to provide on-site coaching of primary care teams. By reinforcing all aspects of the program and demonstrating how to use the Diabetes Registry and how to set appropriate priorities, the diabetes expert team has tried to increase confidence and competence in diabetes management. By the end of 1997, more than 80% of practices had used the diabetes expert team at least once, and more than 50% were doing so regularly. Although the diabetes expert team had direct patient contact with only 7% of patients in those practices, the improvement in outcomes in all patients in those practices was substantial, suggesting that the benefit provided by the diabetes expert team is large.

Not surprisingly, the diabetes expert team visits have been logistically difficult and time-consuming to organize. We identified a nursing or administrative contact person at each of the 25 clinical sites. These persons were sent a schedule of dates for future diabetes expert team visits and were asked to arrange to bring in two to three patients from each of the four to six providers so that joint consultations could take place with the patient, the primary care team, and the diabetes expert team together at the same time. This was not always possible because of scheduling changes or unforeseen emergencies, but the program has been generally well received. As we enter our fourth year of diabetes expert team visits, the main feedback we have received is that more clinical sites (including contracted network providers) want to be involved and that most sites would like the diabetes expert team to come more often, even if for less time. In the future, rather than spending a whole day at each site every 3 months, we are planning for each clinic to have the on-site support for half days every 6 weeks.

It is difficult to estimate the economic implications of these programs. Some additional staff time has been required to develop and support the ongoing implementation of the guidelines and the on-line registry. However, the economic effect of diabetes on a managed care organization is obviously large (28), and the potential for cost savings is huge. We have already begun to identify the major sources of cost of care for our diabetic patients at GHC (27, 29), and we plan to follow these costs prospectively over the next few years as this program is fully implemented and refined.

Diabetes was selected, along with a few other conditions, as a target for comprehensive improvement efforts at GHC in 1994. Others (30–32) have shown that the mere availability of guidelines and the use of didactic lectures do not substantially change physician behavior. More personalized physician education accomplished through tutorials (33), academic detailing (34), or consultation conferences (35) has proven to be more effective. Others (15, 36) have shown that using nurses to manage the caseloads of diabetic patients under the supervision of diabetologists results in improved outcomes. In our study, however, each nurse was the case manager for about 250 diabetic patients, and one diabetologist oversaw four nurses (36). With almost 15 000 diabetic patients at GHC, this approach would require as many as 60 new certified diabetes educators and 14 new diabetologists.

We do not suggest that all diabetic patients can be managed in a primary care setting, but we believe that routine care can be substantially improved by paying systematic attention to the elements in our improvement model. In many health care organizations, the criteria used to determine which diabetic patients are seen in a primary care setting and which are referred to an endocrinologist or diabetologist are arbitrary and are based more on patient preferences than on objective evidence of the complexity of the patient's illness. We hope that by improving the routine aspects of diabetes care with the diabetes expert team and the comprehensive data collected in the Diabetes Registry, we will be able to use objective criteria to identify subsets of diabetic patients who should be seen by a specialty team and will be able to ensure better care for the majority of diabetic patients with less complicated illness.

References

1. Wagner EH, Austin BT, Von Korff M. Organizing care for patients with chronic illness. Milbank Q. 1996;74:511-44.

2. Ayanian JZ, Hauptman PJ, Guadagnoli E, Antman EM, Pashos CL, McNeil BJ. Knowledge and practices of generalist and specialist physicians regarding drug therapy for acute myocardial infarction. N Engl J Med. 1994;331:1136-42.

3. Markson LE, Cosler LE, Turner BJ. Implications of generalists' slow adoption of zidovudine in clinical practice. Arch Intern Med. 1994;154:1497-504.

4. Horner RD, Matchar DB, Divine GW, Feussner JR. Relationship between physician specialty and the selection and outcome of ischemic stroke patients. Health Serv Res. 1995;30:275-87.

5. Brown JJ, Sullivan G. Effect on ICU mortality of a full-time critical care specialist. Chest. 1989;96:127-9.

6. Levetan CS, Salas JR, Willets IF, Zumoff B. Impact of endocrine and diabetes team consultation on hospital length of stay for patients with diabetes. Am J Med. 1995;99:22-8.

7. Hayes TM, Harries J. Randomised controlled trial of routine hospital clinic care versus routine general practice care for type II diabetics. Br Med J (Clin Res Ed). 1984;289:728-30.

8. Verlato G, Muggeo M, Bonora E, Corbellini M, Bressan F, de Marco R. Attending the diabetes center is associated with increased 5-year survival probability of diabetic patients: the Verona Diabetes Study. Diabetes Care. 1996;19:211-3.

9. Greenfield S, Rogers W, Mangotich M, Carney MF, Tarlov AR. Outcomes of patients with hypertension and non–insulin-dependent diabetes mellitus treated by different systems and specialties. Results from the Medical Outcomes Study. JAMA. 1995;274:1436-44.

10. Ho M, Marger M, Beart J, Yip I, Shekelle P. Is the quality of diabetes care better in a diabetes clinic or in a general medicine clinic? Diabetes Care. 1997;20:472-5.

11. Hurwitz B, Goodman C, Yudkin J. Prompting the clinical care of non-insulin-dependent (type II) diabetic patients in an inner city area: one model of community care. BMJ. 1993;306:624-7.

12. MacKinnon M. General practice diabetes care: the past, the present, and the future. Diabet Med. 1990;7:171-2.

13. Carlson A, Rosenqvist U. Diabetes control program implementation. On the importance of staff involvement. Scand J Prim Health Care. 1998;Suppl 1:105-12.

14. Gruesser M, Bott U, Ellermann P, Kronsbein P, Joergens V. Evaluation of a structured treatment and teaching program for non-insulin-treated type II diabetic outpatients in Germany after the nationwide introduction of reimbursement policy for physicians. Diabetes Care. 1993;16:1268-75.

15. Peters AL, Legorreta AP, Ossorio RC, Davidson MB. Quality of outpatient care provided to diabetic patients. A health maintenance organization experience. Diabetes Care. 1996;19:601-6.

16. Wagner EH. Population-based management of diabetes care. Patient Educ Couns. 1995;26:225-30.

17. Payne TH, Galvin M, Taplin SH, Austin B, Savarino J, Wagner EH. Practicing population-based care in an HMO: evaluation after 18 months. HMO Pract. 1995;9:101-6.

18. Handley MR, Stuart ME. An evidence-based approach to evaluating and improving clinical practice: guideline development. HMO Pract. 1994;8:10-9.

19. Handley MR, Stuart ME, Kirz HL. An evidence-based approach to evaluating and improving clinical practice: implementing practice guidelines. HMO Pract. 1994;8:75-83.

20. McNeely MJ, Boyko EJ, Ahroni JH, et al. The independent contributions of diabetic neuropathy and vasculopathy in foot ulceration. How great are the risks? Diabetes Care. 1995;18:216-9.

21. Rith-Najarian SJ, Stolusky T, Gohdes DM. Identifying diabetic patients at high risk for lower-extremity amputation in a primary health care setting. A prospective evaluation of simple screening criteria. Diabetes Care. 1992;15:1386-9.

22. Litzelman DK, Slemenda CW, Langefeld CD, et al. Reduction of lower extremity clinical abnormalities in patients with non–insulin-dependent diabetes mellitus: a randomized, controlled trial. Ann Intern Med. 1993;119:36-41.

23. Stegmayr BG. A study of patients with diabetes mellitus (type 1) and end-stage renal failure: tobacco usage may increase risk of nephropathy and death. J Intern Med. 1990;228:121-4.

24. Uusitupa MI, Niskanen LK, Siitonen O, Voutilainen E, Pyörälä K. Ten-year cardiovascular mortality in relation to risk factors and abnormalities in lipoprotein composition in type 2 (non-insulin-dependent) diabetic and non-diabetic subjects. Diabetologia. 1993;36:1175-84.

25. Earle KA, Mishra M, Morocutti A, et al. Microalbuminuria as a marker of silent myocardial ischaemia in IDDM patients. Diabetologia. 1996;39:854-6.

26. Von Korff M, Gruman J, Schaefer J, Curry SJ, Wagner EH. Collaborative management of chronic illness. Ann Intern Med. 1997;127:1097-102.

27. Ramsey SD, Wagner EH, McCulloch DK, Newton KH, Sandhu N. The cost of treating foot ulcers in patients with diabetes [Abstract]. Diabetes. 1997;46(Suppl 1):62A.

28. Selby JV, Ray GT, Zhang D, Colby CJ. Excess costs of medical care for patients with diabetes in a managed care population. Diabetes Care. 1997;20:1396-402.

29. Newton KM, Ramsey SD, Wagner EH, McCulloch DK, Sandhu N. The use of automated data to evaluate the complication burden of diabetes in a managed care setting [Abstract]. Diabetes. 1997;46(Suppl 1):142A.

30. Davis DA, Thomson MA, Oxman AD, Haynes RB. Evidence for the effectiveness of CME. A review of 50 randomized controlled trials. JAMA. 1992;268:1111-7.

31. Carlson A, Rosenqvist U. Diabetes care organization, process, and patient outcomes: effects of a diabetes control program. Diabetes Educ. 1991;17:42-8.

32. Sawicki PT, Muhlhauser I, Didjurgeit U, Berger M. Improvement of hypertension care by a structured treatment and teaching programme. J Hum Hypertens. 1993;7:571-3.

33. Inui TS, Yourtee EL, Williamson JW. Improved outcomes in hypertension after physician tutorials: a controlled trial. Ann Intern Med. 1976;84:646-51.

34. Soumerai SB, Avorn J. 1990. Principles of educational outreach ("academic detailing") to improve clinical decision making. JAMA. 1990;263:549-55.

35. Vinicor F, Cohen SJ, Mazzuca SA, et al. DIABEDS: a randomized trial of the effects of physician and/or patient education on diabetes patient outcomes. J Chronic Dis. 1987;40:345-56.

36. Legorreta AP, Peters AL, Ossorio RC, Lopez RJ, Jatulis D, Davidson MB. Effect of a comprehensive nurse-managed diabetes program: an HMO prospective study. The American Journal of Managed Care. 1996;2:1024-30.

Acknowledgments

This paper represents an enormous collaborative effort on the part of many persons throughout our organization. In particular, we thank Kristine Odle, Brian Austin, Karen Artz, Rachel Atkins, Melissa Parkerton, Nirmala Sandhu, John Brebner, Dan Kent, William Butts, Kenneth Gross, Donald Miller, Mick Braddick, Matt Handley, Michael Stuart, all the members of the Diabetes Steering Committee, and our patients.

This work was supported in part by grants from the Robert Wood Johnson Foundation.

Correspondence

Edward H. Wagner, MD, MPH, Center for Health Studies, Group Health Cooperative of Puget Sound, 1730 Minor Avenue, Suite 1600, Seattle, WA 98101; e-mail: wagner.e@ghc.org.

This paper is available at ecp.acponline.org.