Chronic diseases persist over a long time frame and ultimately may result in serious adverse health outcomes. Chronic diseases are common in the world, and their frequency is increasing substantially in the United States. Chronic disease management is one of the major categories of work for generalist physicians and health care providers, including family physicians. Better chronic disease management could result in monetary savings for the US health care system. In the United States, most patients do not achieve standard treatment goals before experiencing adverse outcome. The routine health care office visit in the United States was established when acute illnesses were the drivers of our population’s health problems. The typical acute visit format may not be optimal for managing chronic conditions. For these reasons, we initiated a quality improvement project guided by the components of a chronic disease management model and FFM new model characteristics.

A chronic disease care model proposed by Wagner et al identified six key components to improve care in the primary care setting. The components are community resources and policies, health care organization, self-management support, delivery system design, decision support, and clinical information systems. Subsequent research has documented benefit by implementing efforts to address some or all of these six components. These components of chronic disease care interconnect with characteristics of a proposed “new model” of family medicine delineated by the Future of Family Medicine (FFM) Leadership Committee in its initial report (Table 1).

This paper describes process and outcomes of incorporating the chronic disease management model into our family medicine residency clinic. Some practice changes that correspond with FFM characteristics are described in more detail. The changes we describe have significantly improved measures of quality care for one chronic condition. Our institutional review board gave us approval to publish the results of this project.

**Methods**

**Program Design and Implementation**

One individual assumed leadership of a multidisciplinary committee of the residency program clinic addressing quality of care in July 2003. The committee included representatives from all job classifications...
### Table 1

**Characteristics of the New Model of Family Medicine and Corresponding Elements of the Chronic Care Model (CCM)**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Description</th>
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</table>
| Personal medical home | The practice serves as a personal medical home for each patient, ensuring access to comprehensive, integrated care through an ongoing relationship.  
**CCM delivery system design:** Ensure regular follow-up by the care team. |
| Patient-centered care | Patients are active participants in their health and health care. The practice has a patient-centered, relationship-oriented culture that emphasizes the importance of meeting patients’ needs, reaffirming that the fundamental basis for health care is “people taking care of people.”  
**CCM self-management support:** Emphasize the patient’s central role in managing their health. |
| Team approach | An understanding that health care is not delivered by an individual, but rather by a system, which implies a multidisciplinary team approach for delivering and continually improving care for an identified population.  
**CCM delivery system design:** Define roles and distribute tasks among team members. Use planned interactions to support evidence-based care. |
| Elimination of barriers to access | Elimination, to the extent possible, of barriers to access by patients through implementation of open scheduling, expanded office hours, and additional, convenient options for communication between patients and practice staff. |
| Advanced information systems | The ability to use an information system to deliver and improve care, to provide effective practice administration, to communicate with patients, to network with other practices, and to monitor the health of the community. A standardized electronic health record (EHR), adapted to the specific needs of family physicians, constitutes the central nervous system of the practice.  
**CCM: clinical information systems and decision support:** Provide timely reminders for providers and patients. Identify relevant subpopulations for proactive care. Facilitate individual patient care planning. Share information with patients and providers to coordinate care. Monitor performance of practice team and care system. Embed evidence-based guidelines into daily clinical practice. Share evidence-based guidelines and information with patients to encourage their participation. Use proven provider education methods. Integrate specialist expertise and primary care. |
| Redesigned offices | Offices should be redesigned to meet changing patient needs and expectations, to accommodate innovative work processes, and to ensure convenience, comfort, and efficiency for patients and clinicians.  
**CCM: delivery system design:** Ensure regular follow-up by the care team. |
| Whole-person orientation | A visible commitment to integrated, whole-person care through such mechanisms as developing cooperative alliances with services or organizations that extend beyond the practice setting but that are essential for meeting the complete range of needs for a given patient population. The practice has the ability to help guide a patient through the health care system by integrating care—not simply coordinating it.  
**CCM: delivery system design and self-management support:** Give care that patients understand and that fits with their cultural background. Emphasize the patients' central role in managing their health. Use effective self-management support strategies that include assessment, goal setting, action planning, problem solving, and follow-up. |
| Care provided within a community context | A culturally sensitive, community-oriented, population-perspective focus.  
**CCM: self-management support and the community:** Organize internal and community resources to provide ongoing self-management support to patients. Mobilize community resources to meet needs of patients. Encourage patients to participate in effective community programs. Form partnerships with community organizations to support and develop interventions that fill gaps in needed services. Advocate for policies to improve patient care. |
| Emphasis on quality and safety | Systems are in place for the ongoing assessment of performance and outcomes and for implementation of appropriate changes to enhance quality and safety.  
**CCM: health system:** Create a culture, organization, and mechanisms that promote safe, high-quality care. Visibly support improvement at all levels of the organization, beginning with the senior leader. Promote effective improvement strategies aimed at comprehensive system change. Encourage open and systematic handling of errors and quality problems to improve care. Provide incentives based on quality of care. Develop agreements that facilitate care coordination within and across organizations. |
| Enhanced practice finance | Improved practice margins are achieved through enhanced operating efficiencies and new revenue streams.  
**CCM: health system:** Provide incentives based on quality of care. Promote effective improvement strategies aimed at comprehensive system change. |
| Commitment to provide family medicine’s basket of services | A commitment to provide patients with family medicine’s full basket of services—either directly or indirectly through established relationships with other clinicians.  
**CCM: delivery system design:** Define roles and distribute tasks among team members. |
of workers in our clinic. Committee members were recruited based on their individual interest. As work progressed, experts from hospital quality improvement programs, information technology specialists, pharmacologists, students, and leaders from a hospital-based diabetes support and education center attended and contributed to committee work. Monthly 1-hour meetings were convened. Between meetings, tasks and goals were assigned and completed by committee members.

The committee selected diabetes as its focus due to data showing less than optimal management in the United States.\(^8\)\(^9\) We used a quality improvement process called rapid cycle change.\(^{14}\) In brief, this began with measuring a specific diabetes-related quality of care concern. The committee discussed possible ways to address that concern. A task force was assigned to design and implement practice changes to potentially address the concern. A repeat measurement of the problem indicator informed us if the practice change was effective. The practice change was then adopted, modified, or dropped. Remeasurements of the problem indicator continued, and additional changes to improve the problem were initiated if goals were not reached.

Repetitive standard measurements were necessary to use the rapid cycle change process. An electronic medical record (EMR) system (Logician\(^\circledR\), now Centricity\(^\circledR\)) had been implemented in the clinic in 1996. We constructed a “virtual diabetes registry” that captured data on all patients with diabetes entered as a diagnosis in our EMR. We then designed query programs to search the registry and produce a variety of reports. As new potential problems were identified, additional queries were constructed. Health system programmers, using Crystal Reports\(^\circledR\) software, wrote the registry and reporting functions.

Building and refining the registry took about 8 months. Construction required collaboration among clinicians, administrators, staff members, and computer technicians. The registry captured all of our diagnosed diabetic patients who had visited our clinic within the last 2 years. Standard reports were prepared for total practice, individual providers, and individual patients.

This real-time data harvest registry did not require separate data entry, multiple registries for different conditions, or starting from scratch at each new initiative. The registry provided the efficient mechanism to track progress as we implemented practice changes guided by the six domains of the chronic care model (CCM).

Reports of patient progress were distributed and discussed with patients at scheduled office visits (Figures 1 and 2). Reports for individual practitioners were distributed periodically (Figure 3). Total practice reports were produced monthly and reviewed by the committee to guide further changes and inform of results of previous changes (Figure 4). The standard practice report measured the percentage of patients with diabetes at goal for hemoglobin A1C (A1C), low-density lipoprotein cholesterol (LDL), and blood pressure (BP).

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**Figure 1**

**Example Patient Report**

<table>
<thead>
<tr>
<th>Date</th>
<th>Value</th>
<th>Goal</th>
</tr>
</thead>
<tbody>
<tr>
<td>03/04/2005</td>
<td>5.5</td>
<td>Less than 7.0</td>
</tr>
<tr>
<td>12/27/2004</td>
<td>6.2</td>
<td></td>
</tr>
<tr>
<td>03/16/2005</td>
<td>111</td>
<td>Less than 100</td>
</tr>
<tr>
<td>09/28/2004</td>
<td>86</td>
<td></td>
</tr>
<tr>
<td>06/09/2005</td>
<td>181.8</td>
<td>163.6</td>
</tr>
<tr>
<td>05/13/2005</td>
<td>184</td>
<td>165.6</td>
</tr>
<tr>
<td>06/09/2005</td>
<td>124</td>
<td>Less than 130</td>
</tr>
<tr>
<td>05/13/2005</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>06/09/2005</td>
<td>62</td>
<td>Less than 80</td>
</tr>
<tr>
<td>05/13/2005</td>
<td>68</td>
<td></td>
</tr>
<tr>
<td>10/13/2004</td>
<td>10.1 mg/g</td>
<td>Less than 25</td>
</tr>
</tbody>
</table>

HgBA1C—hemoglobin A1C; LDL—low-density lipoprotein cholesterol; BP—blood pressure
Figure 2

Example Patient Report
The report also provided process measures indicating percentage of patients with diabetes who had had foot exams and microalbumin measurements documented within the last year. Additional “special reports” were produced to assess identified problems.

During the construction of the registry, diabetes literature was reviewed and goals published by the American Diabetes Association (ADA) in 2003 were adopted. Practice changes to achieve the goals were proposed.

Several of the practice changes incorporated corresponded with characteristics promoted by the FFM report. Characteristics addressed include advanced information systems, team care, redesigned offices, emphasis on quality, and care delivery in a community context. Practice changes organized according to these five characteristics specified by the FFM reports are described in more detail.

**Advanced Information Systems**

Advanced information systems were central to this effort. The diabetes registry and subsequent reports were dependent on the data stored in our electronic medical record. Modifications of our medical record were necessary to capture items of particular interest, such as diabetic foot exams. The reports measuring practice progress toward our goals were critical for committee guidance. The patient reports were helpful in organizing office visits and goal direction for patients. The practitioner reports reminded...
Team-based Care

Team-based care was the foundation strategy of this effort. The composition of health care teams is not uniformly defined in the literature, but key characteristics of teams have been suggested. Our team’s composition was typical of many practicing physician offices. Our core clinical team included appointment secretaries, accounting representatives, clinic administrators, nursing personnel, laboratory technicians, physicians, nurse practitioners, and resident physicians. All of these individuals were recruited to improve the care and outcomes of our patients with diabetes. The quality committee included representatives from all of these job categories. The committee sought methods by which each member of our clinic could positively influence people diagnosed with diabetes mellitus.

As registry reports became available, committee members identified opportunities for improved care. Committee members then proposed rapid cycle change plans to address identified improvement opportunities. Clinic administrators ratified proposed change recommendations. Clinical team members then implemented suggested changes. Committee members facilitated change implementation in their areas of work in the clinic.

Redesigned Offices

The team approach spawned creative thinking and practice innovations that resulted in redesigned office processes. New styles of planned clinic visits emerged. Monthly group visits for people with complex needs and challenges were initiated. A nurse practitioner conducted these visits. Faculty and resident physicians attended the sessions and provided confidential encounters and medical records for all patient attendees.

Routine office visits were also structured differently. In the new visit process, a clinic secretary electronically searched all scheduled visits each morning and printed patient reports on all scheduled patients with diabetes. Reports were distributed to nurses to attach to encounter forms when the patient was directed to an exam room. The reports prompted nursing staff to begin the conversation with persons about their diabetes care. Providers then reviewed reports with patients and negotiated priorities for improvement. All scheduled visits for persons with diabetes included a focused review of diabetes care even if the visit was scheduled for another purpose. Thus, every scheduled visit became a planned visit for diabetes care improvements.

Emphasis on Quality

The entire project was focused on quality improvement. Intermediate outcomes and care processes were measured to inform the quality improvement progress. Quantitative BPs, A1Cs, LDLs, and weights were tracked. Process indicators including annual microalbumin measurements, foot exam documentation, and frequency of A1C testing were followed. These measures have correlated with improved health for people with diabetes.

Tailored feedback reports were produced and provided to patients, providers, and practice managers. Patient reports summarized complications of diabetes and included goals and graphs of the patient results to illustrate progress. Providers were given a list of their personal patients, most-recent A1Cs, and graphs showing progress of their percent of patients at goal. The provider reports also indicated their percent of patients with A1C checked within the last 6 months. The composite practice reports were widely distributed and displayed throughout the program. They were scrutinized monthly by the quality care team. Specialized reports of newly identified concerns were frequently requested by the committee and were provided within the constraints of the system. For example, percentage of patients with A1C above 9.0% in patients taking insulin was tracked since we sought to increase use of insulin in poorly controlled type 2 diabetes.

Care Delivery in a Community Context

Only 30% to 45% of our patients were at ADA goals at the onset of this project. Our hypothesis was that new strategies to help people change unhealthy behaviors would be critical to increase achievement of those goals.

We implemented a partnership with the community of persons with diabetes, using a community democracy model described by Mendenhall and Doherty. A group of persons with diabetes, their involved care partners, and medical caregivers was convened. Clinicians were asked to encourage patients with diabetes to attend these meetings. A faculty family physician and a psychologist attended each gathering. Shared teaching, leading, and organizing community efforts to improve the environment evolved. Community group members taught about job stress, bias, missing empathy from medical practices, financial difficulties, and problems that were not addressed in standard medical diabetes care resources. The group’s first project was meeting with restaurant owners and managers to promote healthy food options on menus for the entire community. A holiday celebration at a local restaurant...
with a special menu for diabetic patients was organized and funded by faculty donation.

Program Evaluation

The registry enabled continuous evaluation of the program and rapid cycle change efforts. Evaluation parameters included process and intermediate outcomes. All changes were guided by progress toward these goals. Changes that apparently positively impacted these goals were adopted and institutionalized. Changes that did not appear to affect the goals were modified or dropped.

Practice data were collected and entered into statistical process control charts. Descriptive statistics were calculated, including means, standard deviations, and ranges for percent of patients at ADA goals for A1C, LDL, and BP. Foot examinations and microalbumin testing were process standards with a goal of annual documentation. Baseline data was measured in April 2004 and then examined monthly beginning in November 2004 for the earliest reporting indicators developed. The number of observations or reporting periods for analysis ranged from 18 for the earliest indicators developed to 13 for the more-recent indicators. The magnitude and stability of change strategies was analyzed for each of the measures using moving range average and displayed as control charts prepared with QI Macros (Jay Arthur, LifeStar). Change from baseline to current performance for each of the indicators was analyzed using two-sample t tests, assuming equal variances.

Results

Percentages of patients at goal for A1C, LDL, diastolic BP, annual foot exams, and annual microalbumin testing were all significantly improved. The percentage of patients at goal for systolic BP was not improved (Figure 5, Table 2).

This broad team-based quality improvement process also positively influenced staff/provider attitudes. Although a systematic analysis was not done, committee attendance and individual efforts were exemplary. The composition of the Quality Improvement Committee with representation from all facets of the clinic operations has remained stable. Staff persons have expressed personal and job-related satisfaction through the quality care activities. Staff ownership is evidenced in expanded functions such as the receptionists’ role in diabetes care.

Monthly group visits with challenging patients have continued and grown. The community democracy group continued to meet until June 2006. At that time, further meetings were pending evaluation of the initiative. The group had evolved into a primary support group instead of an action group. The effort to impact dining menus in the community was not completed. However, a number of restaurants with diabetes-friendly menus were identified and recognized. There are plans to reconvene the diabetes democracy group in the fall with a design to promote community change. A separate support group is also contemplated.

Discussion

This quality improvement project resulted in significant and sustained improvements in processes and outcomes in our care of persons with diabetes. Use of the chronic care model and the new model of family medicine guided our progress.

We believe objective feedback to patients, practitioners, and practice was a valuable component influencing improvement. The effort was sustained, in part, due to evidence of progress. Objective measurement was possible because of linking sequential events in the practice. The versatile diabetes registry was possible through adoption of an EMR. The registry enabled provision of regular feedback to patients, providers, and practice.

Limitations

One limitation of our method is reliance on intermediate outcomes. While tracking intermediate outcomes was helpful, it is not ideal to measure the ultimate goals of quality improvement. Patient-oriented outcomes such as morbidity, mortality, and cost of care are the ultimate goals. However, intermediate outcomes and practice process changes are likely proxies for patient-oriented outcomes.

Data reflecting patient-oriented outcomes should be available since payers have data on cost of care. In diabetes, health care costs exceed those of nondiabetic persons, largely due to increased hospitalizations and high-cost procedures. If cost information were to be shared with primary care providers, it is possible that new standards of quality could be revealed. Measured improvements in intermediate outcomes and care processes could be correlated with improvement in patient-oriented outcomes. We are negotiating with insurers to access cost report data for patients with diabetes.

There are other limitations regarding the methods and results of this quality improvement project. The registry has limitations. New patients were added to the registry, and old patients (not seen in more than 2 years) dropped off daily. Quality improvement statistical methodology is designed to handle this better than conventional research analysis. Percentages of persons at goal may underestimate improvements in those not at goal, so average A1C values were added to our monthly practice reports. While great progress was measured, this effort targeted only one of many chronic conditions.
Figure 5
Control Chart for HgbA1c < 7.0

HgbA1C at Goal

Table 2
Quality Improvement Data and Significance Testing for Two Most-recent Time Periods, Each Time Period Being at Least 6 Months, and Without Separation in Time

<table>
<thead>
<tr>
<th>Reporting Indicator</th>
<th>First Time Period</th>
<th>Subsequent Time Period</th>
<th>Significance Test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean Percent At Goal</td>
<td>Mean Percent At Goal</td>
<td>P Value (two-tailed)</td>
</tr>
<tr>
<td>HgbA1C</td>
<td>30.1475</td>
<td>34.7525</td>
<td>P&lt;.000002</td>
</tr>
<tr>
<td>LDL cholesterol</td>
<td>24.2425</td>
<td>29.655</td>
<td>P&lt;.002</td>
</tr>
<tr>
<td>Systolic blood pressure</td>
<td>38.51</td>
<td>38.7425</td>
<td>P=.55</td>
</tr>
<tr>
<td>Diastolic blood pressure</td>
<td>42.605</td>
<td>48.015</td>
<td>P&lt;.004</td>
</tr>
<tr>
<td>Foot exam done</td>
<td>55.3925</td>
<td>65.7675</td>
<td>P&lt;.0005</td>
</tr>
<tr>
<td>Microalbumin done</td>
<td>37.0067</td>
<td>42.9733</td>
<td>P&lt;.02</td>
</tr>
</tbody>
</table>

Conclusions
This was a project that involved many practice changes. It is difficult to say if any one change was dominant or if any lesser degree of effort could have produced steady statistically significant improvements. We suspect it is the process of changing practices that matters most, not the individual changes.

Chronic disease cannot be addressed without scrutinizing behavior. Family physicians must be as skillful in motivating persons to change as in prescribing
medications. Our work is ongoing to create practical interventions for use at the point of care. The obesity/diabetes epidemic will be difficult to manage without new skills and models of care adopted and implemented by a revitalized primary care workforce. The chronic care model and the FFM summary provide tools to create, implement, and assess interventions that improve care of people with chronic conditions.

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REFERENCES