Diabetes is a major health problem in the United States. The number of people diagnosed with diabetes has risen from 1.5 million in 1958 to 17.9 million in 2007. Diabetes is associated with increased risk of serious health conditions, including heart disease, renal failure, retinopathy, vascular compromise, peripheral neuropathy, and limb loss. The impact of these multiple comorbidities led to an estimated economic impact of $174 billion in 2007.\textsuperscript{1} Evidence-based management of diabetes can lower the risk of these comorbidities and other complications.\textsuperscript{2,3}

In addition to evidence-based guidelines, measures have been developed to help assess the quality of care that patients receive. The 2008 National Healthcare Quality Report\textsuperscript{4} highlighted several measures across different conditions and concluded that “health care quality is suboptimal and continues to improve at a slow pace.” The report’s sections on diabetes showed suboptimal; for example, foot, eye, and A1C measures were 18, 39, and 88%, respectively. GIM recognized the need to improve diabetes care both for patients and to succeed in the demonstration project.

Local Problem
In March 2006, GIM’s diabetes quality measures were reported and discussed at quarterly provider meetings. Similar to national reports and benchmarking to other DHMC primary care sites, most measures were suboptimal; for example, foot, eye, and A1C measures were 18, 39, and 88%, respectively. GIM recognized the need to improve diabetes care both for patients and to succeed in the demonstration project.

Intended Improvement
GIM met as a group before 2006 to discuss various issues and share information, but specific patient population data were typically not on the agenda. Most of the care delivered was designed relative to acute-care principles. During patient visits, patient information was not easily accessible; therefore, it was difficult to determine whether a patient needed a test or exam. To address the needs of the demonstration project and to improve care, GIM identified areas to improve, which included assessment of workflows, recognition of tests or exams needed for diabetes assessment, and the need for feedback on performance measures.

A multidisciplinary improvement team, including physicians, nurses, and managers, was formed. The purpose of this group was to engage and attract GIM providers and staff to diabetes improvement work. The aim, core to the DHMC mission, was to provide the “best care, in the right place, at the right time, every time.”\textsuperscript{6} Our hypothesis was that instituting workflow changes, having up-to-date test and exam information at the point of care, and setting improvement goals would improve diabetes care and help meet the intent of the CMS demonstration project.

Study Question
The main question GIM addressed in this improvement work was whether providers and staff members could effectively change the delivery of care. It was essential to build knowledge on how to engage providers and staff members in improvement work and to determine what was actually needed to improve diabetes care. Lessons learned here would aid other improvement work in GIM.
Interventions and Measures
Initially, three interventions were identified to meet our aim of improving routine diabetes care. The first two were focused on visit-based care: engaging licensed nursing assistant (LNA) staff in a system-based process of patient preparation and increasing availability of individualized data. The third was to provide increased transparency of monthly data at practice and team levels.

The improvement team encouraged dialogue with providers, LNAs, and management, resulting in identification of target process and outcome measures, including annual eye and foot examinations, annual microalbumin measurement, A1C testing, and pneumococcal vaccinations. LNAs were engaged to assist with modification of workflows and tools, identification of gaps in care, and documentation of actionable items within the electronic medical record (EMR).

The primary data source for diabetes care measures in GIM is the DHMC Data Reporting System, which retrieves data from laboratory and financial systems and from the EMR. A cohort report of these data is generated on a monthly basis. Data are reported for each patient, including their primary care provider, laboratory values, and completion of preventive quality measures.

The second intervention involved identifying patients before their appointments, determining from the EMR whether they needed tests, and documenting these needs on a flow sheet. Figure 1 displays the patient visit–based tool. Automating this process allowed integration of current and additional data into the workflow by using the existing monthly cohort report. Individual patient summary data could be printed in advance of a visit, allowing an LNA to identify necessary exams or tests. Figure 2 displays the second generation of the patient visit–based tool. In addition to diabetes care improvements, quality measures were introduced for patients with heart failure and coronary artery disease because these conditions were included in phase 2 of the CMS demonstration project.

Transparency of process and outcome measures comprised the third
intervention. GIM’s improvement team reviewed aggregate practice-level data and reported at monthly practice-wide staff meetings and provider meetings. Results were analyzed monthly using individual and moving range statistical process control charts as one means of assessing the effectiveness of interventions. Data were analyzed using Microsoft Excel. Special-cause variation was noted if a point was above the upper or below the lower control limit or if eight or more consecutive points were above or below the center line (average). These signals are equivalent to a probability of < 0.01 for both findings.14 During 2008, team-level data became available for each of the three clinical teams within GIM and were included in this reporting.

Results
The quality measures from March 2007 to December 2008 improved. Table 1 shows performance of four diabetes care measures. The most improvement was seen in foot exam rates, which improved from 21 to 59%. This improvement was related to frontline LNA involvement. LNA staff received training by a nurse practitioner who is a certified diabetes educator. Training included didactic and practical skills with return demonstration in foot observations, pedal pulse assessment, and monofilament examination.

Figure 3 is a statistical process control chart that shows patients who received a monofilament test, a component of the annual foot exam. The chart indicates two special-cause variations, in which the monthly rates improved steadily during the 2-year period. The monofilament rate was 16% in 2006, and the first special cause was a linear trend that began in May 2007 as LNAs started to identify needed exams and tests and to document those addressed at the time of the visit. The second special cause occurred when the flow sheet was automated, and the rate for this exam was 56% in December of 2008. Improvement was also seen in the number of patients who received pneumococcal vaccinations. The rate was 60% in 2006. Implementation of standing orders for administration of the vaccine occurred in early 2007 and resulted in the first special-cause variation and an increase in rate to 66%. This process improvement continued until the end of 2008 when the rate reached 75%. Figure 4 shows this quality measure in a statistical process control chart. Improvement in other process measures also showed special-cause variation, which was documented in statistical control charts indicating statistical significance for those measures (charts not shown).

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<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>Pneumococcal vaccination</td>
<td>One pneumococcal vaccination per lifetime</td>
<td>66%</td>
<td>76%</td>
<td>37%</td>
</tr>
<tr>
<td>Foot exam</td>
<td>Annual foot examination</td>
<td>21%</td>
<td>59%</td>
<td>66%</td>
</tr>
<tr>
<td>Microalbumin</td>
<td>Annual microalbumin urine test performed</td>
<td>37%</td>
<td>51%</td>
<td>Not available</td>
</tr>
<tr>
<td>Eye exam</td>
<td>Dilated eye examination performed annually</td>
<td>38%</td>
<td>51%</td>
<td>61%</td>
</tr>
</tbody>
</table>

* Operational definitions: percentage of diabetic patients who have ever received a pneumococcal vaccine; percentage of diabetic patients who received at least one foot exam during the past 12 months; percentage of diabetic patients with at least one test for microalbumin in the past 12 months; percentage of diabetic patients who received a dilated eye exam during past 12 months.

**Discussion**

GIM began with a system response whereby workflows were modified, tools were improved, standing orders were implemented, and staff roles and responsibilities were redefined. Improved performance for the CMS Demonstration Project resulted in performance payments for DHMC, and the project has continued into subsequent phases of additional chronic conditions and prevention.  

Transparency of data at the aggregate practice and team levels raised the awareness of GIM members. Providers verbalized appreciation for the assistance they received (data collection and documentation), and they felt they were able to increase their direct patient encounter time. Empowering the LNAs to own part of the process was a vital step.

**Limitations**

The population initially included adult patients who were diagnosed with type 1 or type 2 diabetes. Since 2008, the population has changed to include a number of type 2 diabetic patients in the geriatric population because two additional geriatricians were added. Current data collection methods and measurement do not take into consideration valid exclusions to explain why all quality measures were not performed for all patients. This may account for some unwarranted variation. Measurement accounts for what was performed and does not include measures that were addressed and determined to be of no additional clinical value, were contraindicated, or were declined by patients.

**Summary**

GIM has implemented several interventions that have resulted in measureable improvement in the care of diabetic patients. Providers and staff members effectively changed the delivery of care. This required their involvement and engagement in the work of changing care. It also required activating and changing the role of LNAs to support the new system.

Further improvement of care is needed and will require exploration into the reasons for variations in care among providers, potential revision of inclusion and exclusion criteria for metrics, identification of potential new interventions, and increased efforts toward population-based programs. Finally, the results discussed here are only related to process-of-care measures. We believe the work done so far has provided a foundation for further improvement, including outcome measures such as eye examinations and A1C measures.

**ACKNOWLEDGMENTS**

This project was supported by DHMC GIM providers and staff and performed as an initial step in chronic disease management.

**REFERENCES**

1. Centers for Disease Control and Prevention: Estimated diabetes costs in the United States in 2007. Available online from

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**Figure 2.** Second-generation DHMC GIM visit-based chronic condition form.
Figure 3. Statistical process control chart displaying percentage of patients receiving monofilament exam. Arrow 1 at May 2007 is when LNA began supporting providers with foot examinations. Arrow 2 at November 2007 indicates when the automated flow sheet was initiated.

Figure 4. Statistical control chart indicating the percentage of patients who received pneumococcal vaccinations. Arrow 1 in early 2007 indicates initiation of standing orders. Arrow 2 at November 2007 indicates initiation of automated flow sheet.

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