Improving Diabetes Care Using a Multitiered Quality Improvement Model

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The authors report the results of implementing a diabetes mellitus guideline in a group practice in which uniform, technology-generated care processes were produced for patients, clinical staff, and providers. The objective was to increase the annual rate of recommended tests and examinations for patients with diabetes and to reduce levels of glycosylated hemoglobin, blood pressure, and low-density lipoprotein cholesterol. A process change for type 2 diabetes mellitus was implemented that included changes in office visit structure, protocol-driven electronic prompts for nursing and physician staffs, clinical decision support built into a new electronic medical record form, and audit with feedback. Twelve primary care physicians treated a total of 1592 patients with diabetes between January 2007 and January 2008. There were prompt and statistically significant improvements in 5 process measures and 2 outcome measures; a quality summary measure showed 8% overall improvement. Statistically significant improvements with moderate effect size were observed after a multitiered intervention. (Am J Med Qual 2009;24:505-511)

Keywords: diabetes; quality improvement; electronic medical record; clinical decision support

Although advances in diabetes treatment in the last part of the 20th century have resulted in impressive reductions in morbidity and mortality, it is widely recognized that diabetes management by primary care physicians in the United States is less than optimal. A variety of tools promote the adoption of clinical practice guidelines, including those formulated by the American Diabetes Association. These tools include telephone reminders, flow sheets, computer-based protocols, and continuous quality improvement methods based on best practice. However, application of these tools individually to improve diabetes care has produced inconsistent results.

The deficiencies in diabetes care are reflective of the relatively slow progression in quality improvement in the physician office setting. Audet et al conducted a national physician survey and found that most physicians do not implement formal quality measurement and improvement methods in their practices. In addition, only one third of physician respondents indicated that they participated in office redesign for quality improvement. Though physician offices offer significant opportunities for having an impact on the cost and quality of health care, their diversity in type, size, and organizational structure renders the development of standard approaches to quality improvement difficult.

The Institute of Medicine (IOM) recommends system redesign as the essential first step toward improving chronic disease quality measures, suggesting that "carefully designed evidence-based care processes, supported by automated clinical information and decision support systems, offer the greatest promise of achieving the best outcomes." However, the IOM makes note of multiple
challenges including the need for tools to organize and deliver care, the need for effective teams, and the need for improved technology to automatically gather, analyze, and present clinical information for patients and team members alike.

We asked the following research question: Can a multitiered intervention that includes quality improvement and automatic computer-based protocols facilitate positive changes in diabetes care delivery? We performed a case study of diabetes care process change in a community practice under the guidance of a quality committee (QC) with Physicians Health Alliance (PHA), a community group practice of primary care physicians in northeast Pennsylvania.

**METHODS**

The study entailed a quality improvement process in a medium-sized community group practice in which 12 clinicians had been using an electronic medical record (EMR; Centricity Office, GE Healthcare, Waukesha, WI) for several years. The study took place in 2007. Initial efforts focused on creating and authenticating a diabetes registry and observing the effect of this validating effort on diabetes process measures. Inclusion criteria for the registries were all active patients at least 18 years of age who had a diagnosis of diabetes mellitus. An active patient was defined as one having an ICD-9 code on the active problem list that identified the patient as diabetic, with a progress note in the EMR associated with an office visit within the prior 12 months. Coding criteria were selected according to standards established by the National Committee for Quality Assurance (NCQA). In an effort to ensure the accuracy of the registries, physicians and their clinical support staff were presented with a report of those patients who had a diagnosis of diabetes on the problem list. Patients misidentified on these reports were removed from the diabetes registry.

At the study onset, we sought buy-in from clinicians by demonstrating to the group unacceptable baseline levels of diabetes care and by developing consensus that process change was urgently needed. Each provider agreed to the goal of achieving the targets set by the NCQA for diabetes care within 6 months. The subsequent implementation process included 4 steps: (1) collection of baseline measures of diabetes care performance; (2) identification and selection of clinical tools to facilitate systematic task completion through visit redesign, EMR prompts, electronic clinical decision support, tailored handouts to encourage patient self-management, and a simplified referral process for diabetes education; (3) a physician education plan; and (4) measurement of the impact of the efforts with feedback to clinicians.

The QC comprised representatives from the information technology department, administration, providers, and the clinical staff of PHA. Various tools that altered the diabetes care process were created. The QC worked to develop multitiered process change based on local best practice and consensus. Specifically, protocol-based computer prompts directed to nursing staff and clinicians served to redesign the office visit. Nursing staff were requested to document patients’ recent eye exam or to refer them for dilated exam; to collect urine specimens; and to request removal of patient footwear in preparation for provider exam. For patients with poorly controlled hypertension, pop-up dialog boxes prompted clinicians to consider addition of thiazide medication or to navigate to the patient’s medication list. Paper-based prompts suggested diabetes education referral when appropriate. Glycemic control and lipid management support were provided through color-coded conditional formatting of patient data on a newly created “Diabetic Excellence Protocols” form (Figure 1). This form, designed to load automatically at the start of each visit, included single mouse click “action buttons” for easy printing of medication lists, diabetes education topics, and consultation requests for diabetes educators. Diabetes self-management education was integrated into the process by 3 methods. First, a diabetes handout with tailored, patient-specific information and recommendations printed automatically at visit outset when lab data were current. This handout provided clinicians with an opportunity to highlight areas of shared concern. Second, clinicians were prompted to refer the patient for formal diabetes education when documentation of such education was lacking. Furthermore, the referral process itself was streamlined so that a single click on the Diabetic Excellence Protocols form printed a referral sheet that was faxed to diabetes educators. Finally, action buttons on this form allowed immediate printing of handouts for a variety of self-management topics. This allowed clinicians to provide written material to patients that reinforced messages delivered during the visit.

The study indicators, listed in Table 1, were based on recommendations from the American Diabetes
Association and others. Of these, 8 indicators were process measures, reflecting whether recommended tests were performed; 4 were outcome measures, reflecting whether patients achieved recommended treatment goals. A summary measure termed the diabetes summary index was calculated as the mean of the 12 measures. For the primary analyses (Table 2), we calculated practice-level performance for each measure at baseline and follow-up and compared changes by paired t tests.

Each month, beginning in March 2007, the authors sent practice-level reports of study indicators to all practices. SAS-Enterprise Guide 4.1 (SAS-EG; SAS Institute Inc, Cary, NC) was used to extract patient activity during the previous month. To protect patient confidentiality, the research was performed using only the unique, anonymous numerical identifier for each patient. SAS-EG extracted demographic information such as age, race, sex, diagnoses, medication, laboratory data, and vital signs. The text of progress notes, consultation reports, and discharge summaries was not extracted. Provider reports used conditional formatting to illustrate for each clinician his or her performance in comparison to the anonymous data of other individual clinicians.

### Educational Process

In June 2007, clinicians were provided with educational material and asked to complete a self-study course developed by American College of Physicians. Implementation meetings were held in early July 2007. All clinicians attended one of the meetings. Two major activities occurred at these meetings. The first activity was a demonstration of the redesigned diabetes visit as envisioned by the QC. The second activity was a demonstration of the technique of motivational interviewing delivered by a local expert in this technique.

### Measurements

Major outcomes of the analyses were expressed at the practice level. For each practice, 12 proportions were calculated that corresponded to the 12 study indicators (Table 1). For each study indicator, the proportion corresponded to the percentage of diabetes patients in that practice who had met that study indicator’s target. In addition to the 12 specific study indicator outcomes, a summary measure was constructed for each practice. This summary measure, which we termed the diabetes summary index, reflected the average percentage of the 12 targets met by patients in that practice.

### Six clinics comprising 12 physicians were included in the analyses; 2 were family medicine physicians, and 10 were internal medicine physicians. These practices had 24,650 active patients who were at least 18 years of age on January 1, 2007, 1250 (5.1%) of whom had a diagnosis of diabetes mellitus. On January 1, 2008, the practices had 24,895 active patients who were at least 18 years of age, 1592 (6.4%) of whom had a diagnosis of diabetes mellitus. The average age of the diabetes patients
RESULTS

At project outset, initial queries on the patients’ problem lists revealed that 632 of 1882 “diabetic” patients were misidentified. The problem dated from the purchase of the group’s EMR system. Early versions of the software allowed use of a “Family Hx” modifier using ICD-250 instead of the correct V18.0 code. We calculated the “improvement” of process measures, which could be noted merely by correcting this particular inaccuracy in the diabetes registry (Table 3).

Table 2
Performance for Study Indicators at Baseline (January 1, 2007) and Follow-up (January 1, 2008)

<table>
<thead>
<tr>
<th>Process measures</th>
<th>Percentage of Patients at Targets Among 12 Practices</th>
<th>Absolute Change in Percentage of Patients at Target Between January 1, 2007, and January 1, 2008</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10th Percentile Mean 90th Percentile</td>
<td>10th Percentile Mean 90th Percentile</td>
</tr>
<tr>
<td>Hemoglobin A1c in prior 6 months</td>
<td>49.2 63.7 75.2</td>
<td>63.4 73.8 87.1</td>
</tr>
<tr>
<td>BP in prior 6 months</td>
<td>86.3 92.4 97.2</td>
<td>90.3 94.2 97.0</td>
</tr>
<tr>
<td>LDL cholesterol in prior 12 months</td>
<td>76.4 86.1 92.1</td>
<td>80.3 88.9 95.7</td>
</tr>
<tr>
<td>HDL cholesterol in prior 12 months</td>
<td>72.5 83.1 90.9</td>
<td>76.5 86.6 93.3</td>
</tr>
<tr>
<td>Triglycerides in prior 12 months</td>
<td>74.2 85.5 92.1</td>
<td>80.3 89.0 96.0</td>
</tr>
<tr>
<td>Urinary microalbumin in prior 12 months</td>
<td>16.3 45.6 72.2</td>
<td>53.0 66.8 90.7</td>
</tr>
<tr>
<td>Dilated eye exam in prior 12 months</td>
<td>13.0 43.3 71.8</td>
<td>20.9 55.8 81.4</td>
</tr>
<tr>
<td>Foot exam in prior 12 months</td>
<td>12.5 50.8 86.8</td>
<td>67.6 85.4 98.0</td>
</tr>
</tbody>
</table>

Outcome measures

| Most recent glycosylated hemoglobin <7% | 37.3 46.7 53.6 | 34.6 49.6 59.3 | 3.0 7.0 -1.5, 7.4 .08 |
| Most recent BP measurement <130/80 mm Hg | 24.2 40.9 52.1 | 34.7 49.4 66.7 | 8.5 7.7 3.6, 13.3 .003 |
| Most recent LDL cholesterol <100 mg/dL | 51.0 61.3 76.3 | 53.2 65.2 74.6 | 3.9 6.7 -0.4, 8.1 .036 |
| Most recent HDL cholesterol at target† | 26.9 35.6 39.8 | 30.3 36.8 45.3 | 1.1 6.5 -3.0, 5.3 .55 |
| Diabetes summary index | 50.1 61.2 70.0 | 61.6 70.1 78.1 | 8.87 6.3 4.9, 12.9 <.001 |

Abbreviations: BP, blood pressure; LDL, low-density lipoprotein; HDL, high-density lipoprotein.
*P values are based on paired t tests.
†HDL target ≥40 for men, ≥50 for women.

Changes in Performance of Study Indicators

The average diabetes summary score was 61.2% on January 1, 2007 (10th percentile, 50.1%; 90th percentile, 70.0%). On January 1, 2008, the average diabetes summary score was 70.1% (10th percentile, 61.6%; 90th percentile, 78.1%). The 12-month improvement in the mean diabetes summary score was 8.87% (95% confidence intervals = [4.9, 12.9]). Statistically significant improvement occurred for 5 of 8 process measures and for 2 outcome measures. Ranked by effect size, the greatest statistically significant improvements (more than 10%) occurred in documentation of foot exams and urinary microalbumin.

on January 1, 2007, was 67.7 years (standard deviation = 13.9), and 46.8% were male.
DISCUSSION

Tai et al\(^{18}\) noted the importance of ensuring an accurate database prior to initiating data collection for continuous quality improvement efforts. Our data support his findings. Registry cleanup is a vital first step that must occur prior to baseline data collection.

The findings presented in this report suggest that community group practices using EMRs that are customizable and reportable may be able to successfully use quality improvement methods, built-in protocols, and advanced clinical decision support to redesign health care processes. Furthermore, when these methods are used in the setting of shared goals, very rapid rates of improvement of quality measures may result. Previously published interventions\(^{19,20}\) have required 18 months at the minimum, and as long as 5 years generally, to demonstrate as much as an 8\% overall improvement in quality measures. Our intervention yielded a similar level of improvement in 12 months. The improvements occurred across a spectrum of indicators. Performance improved for practices performing at a range of levels at baseline, and there were comparable increases in the mean, 10th percentile, and 90th percentile measure of the diabetes summary index.

The foundation of our process redesign was an electronic form that loaded automatically at the start of each visit. Schnipper et al\(^{21}\) have noted that electronic forms as a part of clinical decision support systems have had limited effectiveness for a variety of reasons, including lack of integration into work flow, software usability issues, and relevance of the content to the patient at hand. Our form was carefully designed by the PHA Centricity project manager, who had special expertise in form development, working in concert with a physician-programmer. The result was a fully integrated form with robust clinical decision support. The staff has reported no issues with form usability.

A prominent feature of our intervention was provider-level reports that allowed anonymous peer comparison. Unlike manual chart audits, the reports provided by this project were highly automated, involving a few minutes of practice staff time each month. Tangible benefits in our case included recognition status on the NCQA Web site. As practice-level implementation progressed and audit feedback occurred, most practices found that the effort required an increased frequency of visits for patients with diabetes, enabling more consistent monitoring of the applicable indicators.

We found that robust improvement in quality measures can occur in very short time periods when clinicians are motivated by a common goal, when quality is built into the encounter, and when regular audit and feedback are provided.

There are 3 important limitations of the present study. First, there was no comparison group, and it is not possible to be certain that the improvements noted among the 12 practices were a result of the study interventions and not merely a result of changes that would have occurred independently without the process change. Although diabetes care continues to improve in the United States,\(^{23}\) the magnitude of the observed benefits makes it unlikely that the improvement in this study was entirely because of external factors. The 2005 National Healthcare Quality Report (NHQR) documented a median 1-year improvement of only 2.8\% in overall care quality, which is approximately one third of the

### Table 3

Comparison of Process Indicators Obtained From Queries of “Raw” Data Without Correction of Inaccurate Diabetes Diagnosis Versus “Cleaned” Data From Accurate Diabetes Registry, January 2007

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Raw Data (n = 1882)</th>
<th>Accurate Data (n = 1250)</th>
<th>Difference</th>
<th>P value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hemoglobin A1c in prior 6 months</td>
<td>59.1</td>
<td>63.7</td>
<td>4.6</td>
<td>.003</td>
</tr>
<tr>
<td>Blood pressure in prior 6 months</td>
<td>92.3</td>
<td>92.4</td>
<td>0.0</td>
<td>.9</td>
</tr>
<tr>
<td>LDL cholesterol in prior 12 months</td>
<td>85.2</td>
<td>86.1</td>
<td>0.8</td>
<td>.2</td>
</tr>
<tr>
<td>HDL cholesterol in prior 12 months</td>
<td>81.6</td>
<td>83.1</td>
<td>1.5</td>
<td>.05</td>
</tr>
<tr>
<td>Triglycerides in prior 12 months</td>
<td>84.6</td>
<td>85.5</td>
<td>0.9</td>
<td>.2</td>
</tr>
<tr>
<td>Urinary microalbumin in prior 12 months</td>
<td>41.1</td>
<td>45.6</td>
<td>4.5</td>
<td>.001</td>
</tr>
<tr>
<td>Dilated eye exam in prior 12 months</td>
<td>39.7</td>
<td>43.3</td>
<td>3.6</td>
<td>.003</td>
</tr>
<tr>
<td>Foot exam in prior 12 months</td>
<td>46.3</td>
<td>50.8</td>
<td>4.6</td>
<td>.007</td>
</tr>
</tbody>
</table>

Abbreviations: LDL, low-density lipoprotein; HDL, high-density lipoprotein.

*P values are based on paired t tests.
annualized improvement in our diabetes summary index. It is also impossible to ascertain whether the increased motivation resulting from shared goal setting or external factors was most responsible for the improvements noted. Second, our results may not be generalizable to the majority of physician practices in the United States. Our group was fortunate to have implemented a fully functional EMR in 2001. DesRoches et al note that only 4% of US practices have such an extensive, fully functional electronic record system capable of providing “reminders regarding guideline-based interventions.” Our group’s well-developed local programming expertise allowed PHA to develop an Excellence in Diabetes Care form that automatically presented to clinicians such reminders en bloc for each patient with diabetes at visit start. A third limitation is that the indicators included in this study reflect only a subset of guidelines for management of diabetes care. Other important indicators (eg, provision of antiplatelet therapy, recommended immunizations, nutrition/physical activity counseling) were not assessed.

CONCLUSION

It is likely that the performance of practices in this study is much better than the national average. The 2005 NHQR indicated that among patients with diabetes, 70.9% have blood pressure values less than 140/90 mm Hg. In our study, 72% of patients had blood pressure values less than 140/80 mm Hg at study start; this improved to 76% at completion of the study. Similarly, the NHQR reported that foot exams were performed for 72% of patients with diabetes, in contrast with the 85% in our study, and that glycosylated hemoglobin was less than 7% in 39.8% of patients with diabetes, whereas our practices achieved this target in 50% of patients. These findings suggest that quality improvement programs for practices that have good EMR capacity can allow care process redesign among primary care practices to improve the delivery of medical care.

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REFERENCES


