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Improving Performance in Diabetes Care: A Multicomponent Intervention

ORIGINAL ARTICLE

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CONTEXT. Compliance with recommendations from the American Diabetes Association for management of patients with diabetes is not optimal. Changing physician practice patterns with provider-focused interventions can be difficult. We report results after implementation of a type 2 diabetes mellitus guideline.

OBJECTIVE. To increase the annual rate of microalbumin/urine protein testing, dilated eye examinations, and foot examinations for patients with diabetes and to reduce overall levels of hemoglobin A_{1c} (Hb A_{1c}).

DESIGN. Before–after study.

INTERVENTION. From April 1996 to June 1998, a guideline on type 2 diabetes mellitus was implemented with multicomponent interventions. These included small group educational sessions led by opinion leaders, an electronic version of the guideline, audit with feedback, and enhanced clinical orders support. Medical records of random samples of patients with diabetes were audited for specific diabetes performance measures on a monthly basis. Baseline data were compared with results at the end of the implementation effort.

SETTING. Southeastern Minnesota, excluding Olmsted County.

PARTICIPANTS. Adult patients seen at one practice of 18 general internists.

OUTCOME MEASURES. Outcome measures included Hb A_{1c} values and annual performance of a urine protein test, foot examination, and dilated eye examination.

RESULTS. Gradual, sustained, and statistically significant improvements in the three annual performance measures were observed. Urine protein testing increased from 24% to 66% ($P = 0.001$), dilated eye examinations increased from 63% to 84% ($P = 0.001$), and foot examinations increased from 86% to 97% ($P = 0.001$). Mean Hb A_{1c} values ± SD also improved from 7.8% ± 1.0% to 7.1% ± 0.7% ($P < 0.001$) in patients who received continuing care for diabetes.

CONCLUSIONS. Statistically significant improvements were observed after continuous improvement efforts were focused on providers in an individual group practice. When used to implement a diabetes guideline, such interventions may improve delivery of services and reduce Hb A_{1c} levels in patients with diabetes.

Edited by Steven Woloshin, MD, MS

See related editorial on pages 247–249.

Approximately 16.7 million people in the United States have diabetes—5.4 million cases of these remain undiagnosed.[1] Diabetes is a major cause of morbidity and mortality in the United States. It is estimated that patients with diabetes

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incurred $77.7 billion in total medical expenditures in 1997.[2] These figures will continue to grow as the prevalence of diabetes increases.

A growing body of evidence shows that outcomes improve with appropriate management of diabetes.[3, 4] Despite this evidence, primary care providers have been slow to adopt the published standards of care recommended by the American Diabetes Association.[5] Current medical practice for managing diabetes, a chronic disease, often does not result in appropriate therapy, control, or patient satisfaction.[6] However, developing and implementing evidence-based guidelines through provider education, reminders, and increased interaction between generalists and specialists may lead to care that improves outcomes.[7] We report on the implementation of a guideline for type 2 diabetes mellitus in one primary care site at the Mayo Clinic, Rochester, Minnesota.

Methods

Diabetes Guideline

The guideline was developed in collaboration with the Institute for Clinical Systems Improvement, Bloomington, Minnesota.[8] This not-for-profit organization develops evidence-based practice guidelines through the collaboration of member groups. The guideline for type 2 diabetes mellitus consisted of an algorithm outlining a resource-efficient, evidence-based approach to diagnosis and management of diabetes.[9] The guideline was peer reviewed and then reviewed on an annual basis to ensure that it remained consistent with medical advances.

Setting

The Mayo Foundation is a not-for-profit corporation based in Rochester, Minnesota. Mayo is a physician-led team that works in clinical practice, education, and research in a unified, multicampus setting. Our results represent implementation efforts at one patient care site, a practice of 18 general internal medicine physicians that delivers primary and specialist care to adult patients in southeastern Minnesota, excluding Olmsted County.

Measurements

At baseline and during implementation, Hb A_{1c} levels and rates of performing annual urine protein tests, dilated eye examinations, and foot examinations were measured. Data were abstracted monthly on a random sample of 20 patients. Each patient could be selected only once per quarter. Data were collected monthly from the last quarter of 1995 through 1998. We obtained a group of established patients with diabetes for abstraction purposes by defining the population as any adult patient who 1) had a visit in the sample month at which diabetes was indicated with codes from the International Classification of Diseases, Ninth Revision (codes 250.00 to 250.93) and 2) had had an additional visit in the past 11 to 24 months.

Hemoglobin A_{1c} values were obtained electronically from the entire eligible population tested between

TABLE 1
Definitions of Measurements

MEASUREMENT	DEFINITION
Hb A_{1c} level*	Laboratory converted glycosylated hemoglobin values to Hb A_{1c} values using the following conversion formula: Hb A_{1c} = (glycosylated hemoglobin) × 0.61 + 2.1. Most patients (90% to 98%) had Hb A_{1c} measured at least every 6 months. For pre- and postimplementation comparisons, the first value in the period sampled was used for the preimplementation data point and the last value in the period was used for the postimplementation data point.
Urine protein	Random or 24-hour urine microalbumin test or a 24-hour collection for urine protein performed in the past 12 months.
Dilated eye examination	Considered completed if examination by a Mayo ophthalmologist was documented or if a patient-reported eye examination could be verified as being performed in the past 12 months.
Foot examination	Considered completed if documented in the chart in the past 12 months. The definition of a foot examination was consistent with the American Diabetes Association–National Committee on Quality Assurance Provider Recognition Program.

**Hb = hemoglobin.*

October 1995 and September 1996 and between January 1998 and December 1998. To reduce any potential bias caused by selective disenrollment of patients with poorly controlled diabetes, we performed a paired analysis of Hb A_{1c} levels that was restricted to the 82 baseline patients whose levels were measured before and after implementation. Measurement definitions are given in **Table 1**. Data from patients who had previously withheld permission to access their medical records for research were excluded, as required by Minnesota state law. No seasonal effects are expected to have influenced our measures. Statistical comparisons are based on chi-square tests and *t*-tests contrasting preimplementation (October 1995 to March 1996) and postimplementation (July to December 1998) periods. Assessment of changes in Hb A_{1c} levels among the cohort of patients tracked over time was based on a paired *t*-test comparing the earliest value from the baseline period with the most recent postimplementation laboratory value.

Intervention

Several strategies were used to change the care of patients with diabetes during the implementation period. A physician from the practice led the implementation effort and could be considered a "disease champion" for diabetes. The implementation activities are summarized in **Table 2** and outlined here.

Guideline Distribution

The guideline was made available to clinicians in print form and on computer workstations. The electronic version of the guideline could be accessed on the local intranet and searched using hypertext; it was available throughout the medical campus, including all examination rooms. Key aspects of the guideline were presented in a one-page executive summary (**Appendix A**), which was placed at the beginning of the guideline. The executive summary of the guideline was reinforced at practice meetings and through e-mail messages.

Provider Education

Endocrinologists who were opinion leaders in diabetes conducted small group educational sessions. These sessions were given at the local practice site and focused on evidence supporting the management of diabetes as recommended in the guideline. One session was devoted solely to the applicability of microalbumin testing and stressed the evidence supporting this testing in patients with type 2 diabetes mellitus.[10–12]

Feedback

On a quarterly basis, physicians at the practice site received feedback on their measures of current diabetes performance. Data that represented the practice as a whole were displayed at practice meetings and through e-mail messages. Provider-specific data on the performance of urine protein testing were distributed to the practice once during the implementation period. No other provider-specific data were shared with the practice.

Orders Support

As part of an overall program to develop electronic medical records, the physicians in this practice had access to an electronic orders system capable of ordering all available clinical tests and consultations. A feature of this program allowed a cluster of tests to be ordered

TABLE 2
Multicomponent Intervention

COMPONENT	COMMENT
Guideline	Developed by the Institute for Clinical Systems Improvement. Peer-reviewed. Printed copies disseminated to all providers. Electronic version available on all clinic workstations.
Education	Small group educational sessions at the practice led by an endocrinologist. A 1-hour overview of type 2 diabetes mellitus was given annually over lunch. One session specifically on use of microalbumin testing was given during the first year of guideline implementation.
Feedback	Data representing results of the entire group were displayed quarterly at practice meetings. Data were also summarized and distributed through brief quarterly e-mails to the entire practice. Individual feedback was given once for microalbumin testing.
Orders support	Electronic ordering allowing clinicians to input clusters of diabetes-specific orders at one time (e.g., glucose tests; hemoglobin A_{1c} tests; lipid panel; microalbumin tests; urinalysis; and consultations with an ophthalmologist, dietitian, nurse educator, or endocrinologist). The first six orders were preselected to encourage their use on an annual basis.

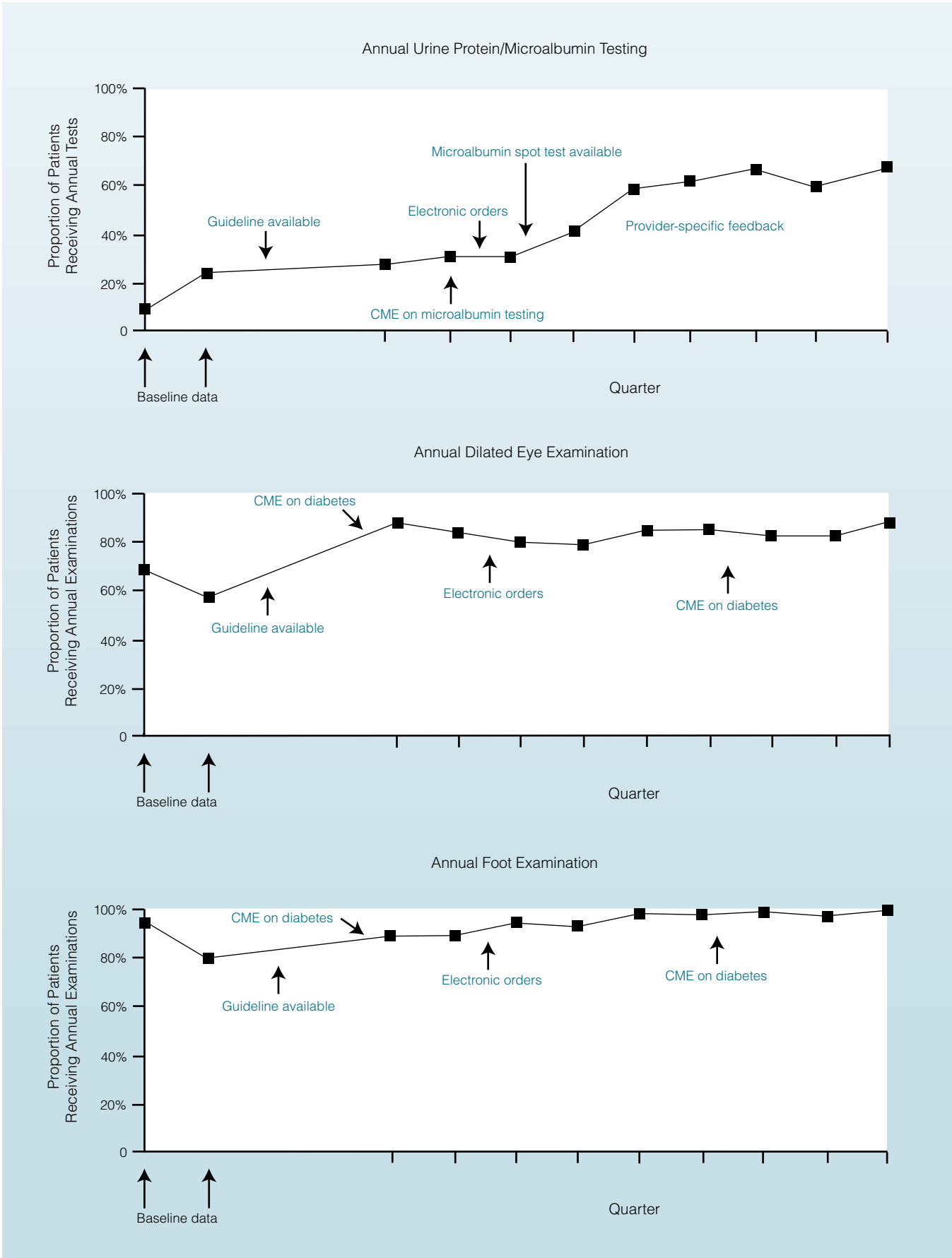

FIGURE 1. Run charts of performance measures. CME = continuing medical education.

with one button. A diabetes-specific "hot button" created a centralized location for the specific orders recommended in the care of patients with diabetes. By using this "hot button," clinicians could call up a selectable list of diabetes-related tests and consultations. Six items on the list—glucose testing, Hb A_{1c} testing, lipid panel, urinalysis, microalbumin testing, and consultation with an ophthalmologist—were preselected to encourage ordering on an annual basis (tests could be deselected if they were not needed) (**Appendix B**).

Results

Gradual, sustained improvements in all diabetes measures were demonstrated throughout the measurement period. Run charts for urine protein testing and provision of both foot and eye examinations are shown in **Figure 1** and demonstrate the impact of the interventions over time. Interventions used for implementation are marked on the run charts at the approximate time of implementation. The Mayo medical laboratory made random spot microalbumin testing available in July 1997, allowing a more convenient measurement of urine microalbumin for patients. Improvements in these diabetes performance measures from before implementation (October 1995 to March 1996) to after (July to December 1998) were statistically significant. On an annual basis, urine protein testing increased from 24% to 66% (P = 0.001), dilated eye examinations increased from 63% to 84% (P =0.001), and foot examinations increased from 86% to 97% (P =0.001).

Measurements of urine protein testing, lipid testing, and provision of both foot and eye examinations demonstrate improvements in the delivery of care. However, reductions in Hb A_{1c} level better reflect patient outcome. A comparison of the entire diabetes population before and after implementation of the guideline showed a statistically significant reduction in the mean Hb A_{1c} level ± SD, from 7.8% ± 1.0% to 7.1% ± 0.7% (P < 0.001).

To reduce potential enrollment bias in the measurement of blood glucose values, we also performed a paired analysis for patients who had available Hb A_{1c} values at baseline and after implementation. To qualify for this analysis, patients were required to have Hb A_{1c} values recorded at baseline and after July 1, 1997. Of the 191 patients who had preintervention values for Hb A_{1c}, 82 also had postintervention values. Overall, Hb A_{1c} levels decreased from baseline assessment to the most recent postimplementation assessment in 69 patients (84%). For the 82 patients with values in both time periods, the mean Hb A_{1c} decreased from 8.02% in the intervention periods to 6.97% in the postintervention period (absolute decrease, 1.05%; 95% CI, 0.82% to 1.27%) (**Figure 2**).

Discussion

Our results show improved delivery of care to patients with diabetes in one practice of 18 internal medicine physicians (providers did not change during the study period). Implementation techniques included local, small

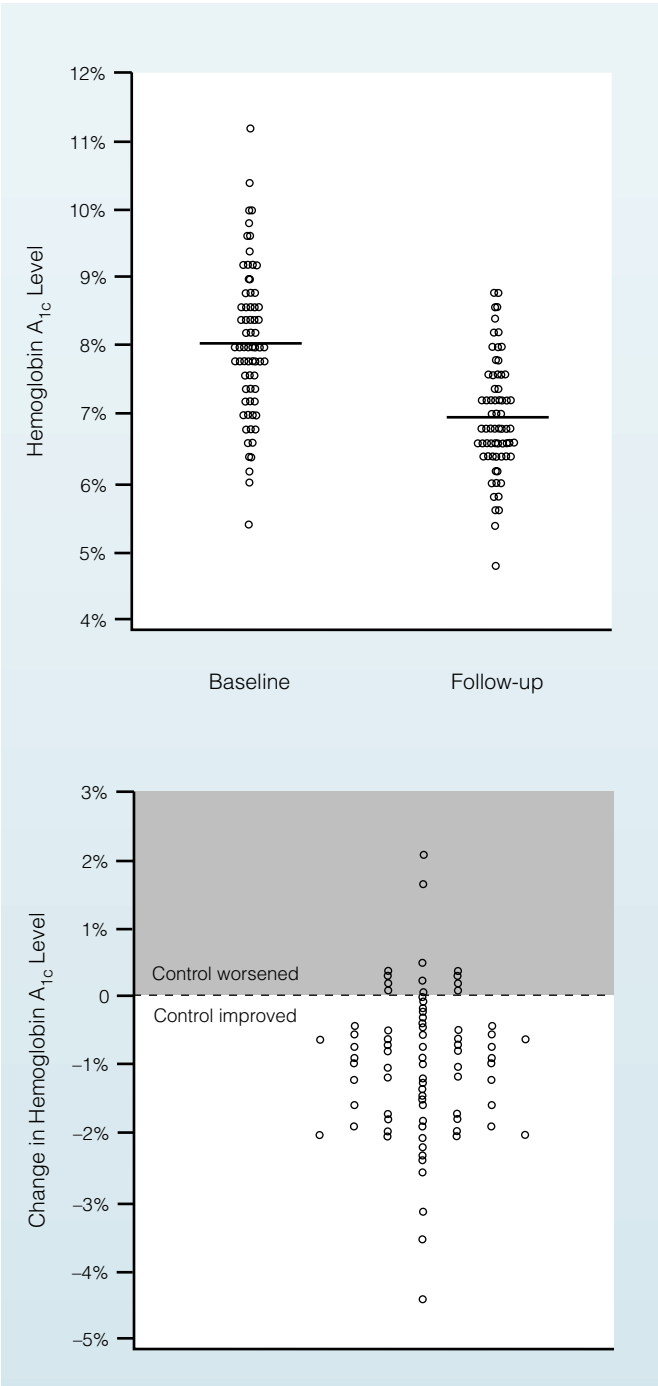

FIGURE 2. Paired analysis of glycosylated hemoglobin A_{1c} levels for the 82 patients with data available before and after implementation of the guideline. Top. Distribution of Hb A_{1c} values at baseline and follow-up. The horizontal line indicates the mean value. **Bottom.** Distribution of changes in Hb A_{1c} values. Values improved in 69 of 82 patients (84%).

group sessions of continuing medical education given by opinion leaders, audits with feedback of practice-level quarterly data, and computer support consisting of a single site for diabetes orders, as well as access to the diabetes guideline through a computer workstation in each examination room. In addition to statistically significant improvement in diabetes performance measures, we also observed improvement in Hb A_{1c} values. The degree of improvement in Hb A_{1c} levels seen in our study is similar to that previously shown to reduce morbidity when sustained.[4] Clinically significant reductions were observed at both the practice level (i.e., in the practice's overall diabetes population) and at the individual level.

Our results are limited by the lack of a comparison group, since the interventions were directed at the entire practice. Secular trends and co-interventions, independent of our intervention, may have affected the results. Specific changes in patient management secondary to the increased rate of Hb A_{1c} testing were not monitored. Some of the improvements noted in performance of foot and eye examinations probably represent providers' improved documentation efforts. We did not measure the number of hypoglycemic events, but the providers did not report excess incidences of hypoglycemia. It is not known whether delivery of care for disorders other than diabetes was compromised by the interventions.

Although we feel that our findings should be generalizable to other sites, a few issues should be noted. First, a computerized order support system is probably very important, and the absence of such a system may limit the reproducibility of our results. Second, the availability of spot microalbumin testing is also important. In our study, the introduction of such testing seems to have had a major influence on the improved performance of urine protein testing. Finally, we do not know which components of the intervention influenced physician behavior. However, in surveys given at the end of the study, most providers said that they felt the educational sessions, feedback data, and orders support had the greatest impact. For example, more than 75% of the providers attended at least two of the educational sessions, and all but one felt that the educational session influenced their practices. In addition, a majority of the clinicians regularly used the orders "hot button" for their patients with diabetes. In contrast, only two of the providers reported ever using the guideline on the intranet.

Although our uncontrolled study is not definitive, our data suggest that a multicomponent provider-based intervention can enhance physician performance and improve the quality of diabetes care. Population-based health care and disease-specific patient registries are clearly important next steps.[13, 14] Efforts at replicating our results in other primary care areas at the Mayo Clinic are ongoing. An electronic diabetes registry has been developed and will undergo pilot testing. We have also begun to explore the use of group visits for patients with diabetes. We are hopeful that through better delivery of services and a focus on disease management, we can continue to improve outcomes for our patients with diabetes.

Take-Home Points

- **Physician compliance with diabetes treatment guidelines has not been optimal.**
- **We implemented a multicomponent intervention to help physicians improve their performance with respect to three aspects of diabetes care: testing for proteinuria, annual dilated eye examination, and annual foot examination.**
- **The intervention consisted of disseminating a diabetes care guideline, small group education sessions with an endocrinologist, practice-level performance feedback, and an electronic order support system.**
- **In the 2 years following implementation of the intervention, we noted improved compliance with recommended urine, eye, and foot examinations as well as a small decrease in mean Hb A_{1c} levels.**
- **Although our uncontrolled study is not definitive, our data suggest that a multicomponent, provider-based intervention can enhance physician performance and improve the quality of diabetic care.**

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Appendix A. Guideline Executive Summary*

Goals

- Improve accuracy of diagnosis.
- Improve glycemic control.
- Improve use of aggressive cardiovascular risk factor reduction.
- Improve screening for microalbuminuria.
- Improve screening for eye complications.
- Increase frequency of foot examinations.
- Promote effective patient self-management of diabetes.

Diagnosis

- Two fasting blood glucose levels >126 mg/dL, or
- Random blood glucose levels >200 mg/dL plus symptoms: polyuria, polydipsia, blurred vision, vaginitis, polyphagia, and unexplained weight loss.

Treatment Goals

1. Glycosylated hemoglobin level <8% or Hb A_{1c} level <7%.
2. Low-density lipoprotein cholesterol level <100 mg/dL with coronary artery disease or <130 mg/dL without coronary artery disease.
3. Blood pressure <130/85 mm Hg.

Laboratory Follow-up

1. Measurement of glycosylated hemoglobin every 6 months. (Quarterly testing may assist in the management of insulin-treated patients or in non–insulin-treated patients with poor metabolic control.)
2. Measurement of microalbumin and urinalysis every 12 months in patients < 70 years of age or in those ≥ 70 years of age at the discretion of the provider.
3. Measurement of total cholesterol, triglyceride, high-density lipoprotein cholesterol, and calculated low-density lipoprotein levels every 12 months.

Medical Evaluation

1. Regular visits should be scheduled semiannually or quarterly if the patient is receiving insulin. More frequent visits may be necessary if treatment goals are not achieved.
2. Monitor blood pressure at each visit.
3. Include foot examination.
4. Include assessment of tobacco use.

Dilated Eye Examination Done Annually

**This summary was updated throughout the implementation period to arrive at this version.*

Appendix B. Screen Shot for the Diabetes "Hot Button" in the Electronic Ordering System