

Impact of a Program to Improve Adherence to Diabetes Guidelines by Primary Care Physicians

M. SUE KIRKMAN, MD^{1,2}
SUSANNA R. WILLIAMS, MSPH¹

HELENA H. CAFFREY, MS¹
DAVID G. MARRERO, PHD¹

OBJECTIVES — Previous studies have shown that primary care physician (PCP) adherence to diabetes guidelines is suboptimal. We sought to determine the state of diabetes care given by independently practicing PCPs in a rural county in Indiana and whether a multifaceted intervention targeting PCPs, patients, and the health care system would improve adherence to diabetes guidelines.

RESEARCH DESIGN AND METHODS — Baseline audits to assess adherence to diabetes guidelines were done on charts of the seven PCPs in the county. Audits were repeated after development of local consensus guidelines and feedback of baseline performance and after implementation of various interventions (practice aids, physician detailing, patient education sessions, and implementation of computerized individual meal planning).

RESULTS — Before any intervention, rates of adherence to guidelines were low (15% for foot exams, 20% for HbA_{1c} measurement, 23% for eye exam referrals, 33% for urine protein screening, 44% for lipid profiles, 73% for home glucose monitoring, and 78% for blood pressure measurements). One year after development of local consensus guidelines and feedback of baseline performance, significant improvements were seen in blood pressure measurements (71 vs. 83%; $P = 0.002$), foot exams (19 vs. 42%; $P < 0.001$), HbA_{1c} measurements (26 vs. 37%; $P = 0.012$), and PCP eye exams (38 vs. 46%; $P = 0.043$); a trend toward improvement was seen in referral to eye specialists (25 vs. 33%; $P = 0.059$). After a second year of multiple interventions, only blood pressure measurements (70 vs. 92%; $P < 0.001$) and foot exams (22 vs. 47%; $P < 0.001$) remained significantly improved; all other areas returned to rates indistinguishable from baseline.

CONCLUSIONS — In busy primary care practices lacking organizational support and computerized tracking systems, sustained improvements in diabetes care are difficult to attain using traditional physician-targeted approaches.

Diabetes Care 25:1946–1951, 2002

The majority of individuals with diabetes in the U.S. receive care for the condition from primary care physicians (PCPs) (1). Several studies involving physician surveys (2–9), chart audits (10–14), and reviews of administrative databases (15,16) have shown that the quality of diabetes care by PCPs is sub-

optimal. An analysis by researchers at the Centers for Disease Control and Prevention suggested that <5% of patients with diabetes receive care that conforms with American Diabetes Association (ADA) guidelines (17). Poor adherence to guidelines may occur because physicians are not aware of or do not understand the

rationale behind the guideline (18) or because patients refuse to undergo recommended interventions (19–21). More commonly, however, lack of adherence stems from “system” factors, including physicians not remembering screening guidelines in the midst of a busy primary care clinic, lack of time to carry out recommended procedures, lack of reimbursement, and lack of resources (22,23).

Organized attempts to improve diabetes care by PCPs have met with mixed success. In general, the most successful interventions involve closed systems such as national health care systems (24,25), the Department of Veterans Affairs (26), or managed care systems (27,28), especially when such systems include computerized medical records (26,28–30). In the U.S., however, many patients—especially in rural states—are cared for by independent physicians who have modest support services and lack computer databases or computerized records. We describe the state of diabetes care by seven independent PCPs in a rural county in Indiana and our efforts to increase these physicians’ adherence to diabetes care guidelines through interventions directed at physicians, patients, and the health care delivery system in that county.

RESEARCH DESIGN AND METHODS

Background and study objectives

The Diabetes Research and Training Center at Indiana University has previously conducted surveys of the state’s primary care physicians to assess reported quality of diabetes care as well as attitudes toward diabetes care guidelines (2,3,7,20,23). Several physicians from one county later requested that we work with physicians in their county to help them improve their care of diabetic patients. We initiated a project with several objectives: 1) to assess, through chart audits, the current state of care in relation to ADA guidelines; and 2) to determine whether a multifaceted intervention (consisting of repeated

From the ¹Department of Medicine, Indiana University School of Medicine, Indianapolis, Indiana; and the ²Roudebush Department of Veterans Affairs Medical Center, Indianapolis, Indiana.

Address correspondence and reprint requests to M. Sue Kirkman, MD, 545 Barnhill Dr., EH 421, Indianapolis, IN 46202. E-mail: mkirkman@iupui.edu.

Received for publication 6 February 2002 and accepted in revised form 4 August 2002.

Abbreviations: ADA, American Diabetes Association; PCP, primary care physician; SMBG, self-monitoring of blood glucose.

A table elsewhere in this issue shows conventional and Système International (SI) units and conversion factors for many substances.

audit and feedback, development of local consensus guidelines, provision of physician and patient education, and provision of practice aids) would improve physician adherence to diabetes guidelines. Our hypotheses were that adherence to diabetes guidelines would improve after feedback was given to PCPs about their baseline performance and after development of local consensus guidelines, and that further improvements would be seen after implementation of the remaining interventions and repeated audit and feedback.

Health care system and demographics of the study county

The study county is rural (population 33,866) (31) and located ~50 miles from Indianapolis. A small hospital (88 beds) and all physician offices are located in the county seat (population 16,662) (31). Primary care is provided by seven physicians (three internists, two general practitioners, and two family practitioners), each of whom maintains an independent practice. The PCPs are all men, with a mean number of years in practice of 21 (range 9–34) at the start of the study.

Other physicians in the county include a general surgeon, an obstetrician, a pediatrician, and a podiatrist. There were no ophthalmologists in the county during the 3 years of the project; however, there were several optometrists. Resources at the county hospital include one RN/Certified Diabetes Educator who conducts diabetes classes and one-on-one education for inpatients or outpatients referred by a physician. Several hospital staff dietitians, none with special expertise in diabetes, provide dietary counseling for referred patients.

Steps of the project

The project involved several sequential steps, to be described more fully below. Initially, the physician group developed consensus guidelines and agreed to adopt them. Chart audits were done on a randomly selected group of patients with diabetes, covering the year before the adoption of the guidelines. Information was provided to each physician about his own performance in terms of adherence to the guidelines, as well as information about performance of the group as a whole. A year after adoption of the guidelines and feedback of baseline performance data to the PCPs, a second chart audit was done; these results were again

presented to the PCPs. A series of interventions, directed at physicians, patients, and the healthcare system, were conducted during the second year of the project. A third chart audit was conducted to encompass the final year.

The project was approved by the Institutional Review Board of Indiana University-Purdue University at Indianapolis. The board deemed that informed consent of patients was not required, since investigators were blinded to all identifying patient data.

Development and adoption of consensus guidelines

A guidelines group was formed, consisting of two PCPs (one internist and one family practitioner), an Indiana University endocrinologist who served as facilitator, the hospital Certified Diabetes Educator, and a nurse from the hospital's Quality Assurance department. The group used the Standards of Care of the ADA for that year (32) as a starting point for developing the guidelines. The endocrinologist presented the evidence for each guideline. The local practitioners discussed each guideline and by consensus either agreed with the guideline or modified it to reflect prevailing practice styles and beliefs. The endocrinologist did not direct the discussion process, other than to occasionally review evidence. In most cases, modifications to the ADA guidelines made them slightly less broad. For example, in several cases the guideline group thought a guideline should be optional for patients over the age of 75. Additionally, the group believed that no microalbumin screening, beyond a yearly urinalysis, should be required for patients already treated with renoprotective antihypertensive drugs. Occasionally the group's guidelines were more stringent than the ADA's (for example, expecting that the PCP should do an annual eye exam in addition to referring the patient to an eye care specialist). The group developed guidelines in eight general areas: self-monitoring of blood glucose (SMBG), HbA_{1c} monitoring, screening for eye complications, screening for foot complications, screening for renal complications, lipid screening and treatment, blood pressure screening and treatment, and smoking assessment and cessation counseling. The consensus guidelines are available from the authors on request.

After the guidelines group developed

the guidelines, an evening meeting was scheduled with all seven PCPs. The two PCP members of the guidelines group presented the guidelines to their colleagues, and after discussion the group agreed to adopt the guidelines. The guidelines were then distributed in paper form to all PCPs. Subsequent newsletters related to the project included the guidelines, as well.

Chart audits and feedback of performance data

Each PCP provided a list of medical record numbers of patients with diabetes (generated from *International Classification of Diseases, Ninth Revision* code 250.xx) who were seen within the prior 6 months. From these lists, a random sample of approximately half of each physician's patients or 30 patients, whichever was larger, was selected for chart audit. Three nursing employees of the hospital were hired and trained by the endocrinologist to abstract charts using audit forms. The full chart audit was begun after inter-rater agreement for five charts was >95%. The initial audit included 275 charts of patients seen at least once during the year before the adoption of the consensus guidelines. A second audit was conducted a year later, after adoption of the guidelines, feedback to PCPs about their performance on the baseline audit, and dissemination of practice aids. The final audit was conducted 2 years later, after a year of interventions directed at physicians, patients, and the health care system.

After each chart audit, feedback was provided to PCPs as follows: demographic and clinical data about patients were tabulated, and data related to adherence to each guideline were analyzed. An evening meeting was scheduled for study staff and the PCPs. Each physician was provided with a document showing his own data as well as pooled data for the physician group. The endocrinologist discussed group data and answered questions about methodology or trends. For year 1 and year 2 audits, a similar process was used, but each PCP's document included his own and pooled data for the baseline year and for the year in question.

Additional interventions

Practice aids. In response to requests from the PCPs, a number of practice aids

were developed and disseminated. These included chart stickers for diabetic patients' charts, which were brightly colored and included cartoons of an eye, a kidney, and a foot. These stickers were meant to trigger the clinic staff to instruct patients to remove their shoes when they were put in the examination room, and to remind PCPs to recommend eye and kidney screening tests. Chart flow sheets were also developed, which facilitated tracking of laboratory results and examinations.

Linked physician and patient education sessions. A series of targeted sessions were held with PCPs, covering various topics related to the guidelines. These sessions were led by specialists from Indiana University School of Medicine and were intended to be evidence-based and practical, with ample time for informal discussion. Within a few weeks of the physician session, an education session on the same topic was held for patients and their families. For example, after physicians talked about dyslipidemia, a session for laypersons entitled, "High cholesterol and diabetes: what can you do?" was held. Project staff provided information for PCP offices to mail to all patients with diabetes about these sessions, and the sessions were also advertised by flyer and in the local newspaper. Patient sessions were conducted by Indiana University specialists or local health care providers; ~80 people attended each patient session. In addition to providing information about the medical topic, presenters emphasized steps patients could take at their physician's office to improve their diabetes care, such as requesting certain tests or examinations.

Computerized nutritional support. A barrier to diabetes care noted by the participating physicians was the inability to develop individualized meal plans for patients. In response to this need, a computer system was installed in the local hospital that enabled the hospital diabetes educator and registered dietitian to assist patients in constructing meal plans. The system, Computer Planned Menus, was developed by our group and previously used as part of successful diabetes interventions (33). The program uses a patient's food preferences to generate daily menus that follow a specific diet prescription, generate shopping lists, and provide complete nutrient analyses.

Analyses

We assessed comparability of baseline characteristics of patients with at least one follow-up audit and those with no data after baseline. Age, sex, race, blood pressure, LDL cholesterol, insulin use (yes/no), diabetes complications, comorbidities, and guideline adherence variables were compared. Means of continuous variables were tested with two sample *t* tests and categorical variables with χ^2 tests. If distributional assumptions were not met for continuous variables, the Wilcoxon's sign-rank test was used.

A chart audit was done if a patient had at least one visit during the year in question. For each adherence guideline studied, we calculated the proportion of audited patients for whom the guideline was followed. We tested effects on adherence at year 1 and year 2 in separate models, because different interventions were applied during these two intervals. Comparisons between baseline and year 1 adherence included only patient charts audited at both of those times. To test change in adherence over time, we used a logistic regression model including physician as a random effect to account for correlation of adherence outcome between patients with the same physician. Compound symmetry was assumed for the structure of the variance-covariance matrix of observations from the same individual at multiple times. We used the same methods to test change from baseline to year 2 adherence, including only patient charts with data in both audits.

Changes in blood pressure from baseline to year 2 were assessed with paired *t* tests. Because of a non-normal distribution, changes in LDL cholesterol and HbA_{1c} were tested with sign-rank tests for differences from baseline to year 2. All analyses were conducted with SAS version 8.2 (SAS Institute, Cary, NC).

RESULTS — Demographic and clinical variables for the 275 patients included in the baseline sample are as follows. The mean age was 61 years, and the sample was overwhelmingly Caucasian. Approximately 40% of the patients used insulin, and 46% had at least one diabetic microvascular complication. All patients had at least one of nine audited comorbid conditions, with hypertension (55%), osteoarthritis (35%), and coronary artery disease (31%) being the most prevalent.

There was a decline in charts that

could be audited in the two subsequent years. One PCP opted not to participate in the project after the baseline chart audit, and for the remaining PCPs, there was attrition in charts available for audit due to patient death, relocation, or loss to follow-up. There were no significant differences in demographic or clinical variables between the three audits, with the exception of LDL cholesterol, which was significantly lower in subjects whose charts were not included in subsequent audits (median 104 vs. 121 mg/dl; *P* = 0.032). Because the physician who dropped out of the project had somewhat lower baseline adherence than the other physicians, adherence to several guidelines was lower in the subset of patients whose charts could not be audited after the baseline period compared with patients whose charts were assessed in subsequent years.

As shown in Table 1, during the year before adoption of the guidelines, adherence to the guidelines was generally well under 80%. Adherence was 15% for foot examinations, 20% for glycohemoglobin testing, 23% for eye exam referrals, 33% for urine protein or microalbumin testing, 35% for smoking cessation counseling, and 44% for lipid testing. Performance was better for SMBG use for insulin-using patients (73%) and blood pressure monitoring (78%). Because of very low rates of documentation of smoking status, smoking cessation counseling was dropped from subsequent chart audits.

Changes in rates of adherence between the baseline year and year 1 (after adoption of guidelines and feedback of performance data to PCPs) are shown in the center columns of Table 1. Statistically significant improvements were seen in blood pressure screening (71 vs. 83%), comprehensive foot exams (19 vs. 42%), glycohemoglobin testing (26 vs. 37%), and annual PCP eye exams (38 vs. 46%). A trend toward improvement that did not reach statistical significance was seen in eye care referrals (25 vs. 33%; *P* = 0.059). No significant changes were seen in SMBG use (77 vs. 84%), lipid testing (46% in both audits), or the combined outcomes of urine protein or microalbumin testing (36 vs. 38%) (all *P* > 0.48).

Changes in rates of adherence between the baseline year and year 2 (after adoption of guidelines, feedback of baseline and year 1 performance data, and all interventions) are shown in the righthand columns of Table 1. Statistically signifi-

Table 1—Adherence to guidelines at baseline and changes at year 1 and year 2

Guideline	Baseline n	Baseline adherence (%)	Year 1 n*	Baseline vs. year 1 adherence (%)	P value†	Year 2 n*	Baseline vs. year 2 adherence (%)	P value†
Blood pressure measured at each visit	270	78	201	71 vs. 83	0.002	159	70 vs. 92	<0.001
Annual PCP eye exam	275	32	206	38 vs. 46	0.043	161	39 vs. 42	0.530
Annual referral to eye specialist	275	23	206	25 vs. 33	0.059	161	26 vs. 21	0.251
Annual comprehensive foot exam	275	15	206	19 vs. 42	<0.001	161	22 vs. 47	<0.001
≥2 HbA _{1c} measurements in a year‡	235	20	169	26 vs. 37	0.012	127	29 vs. 30	0.867
Annual lipid profile‡	235	44	169	46 vs. 46	1.00	127	50 vs. 43	0.196
Annual protein or microalbumin test‡	235	33	169	36 vs. 38	0.689	127	39 vs. 30	0.054
Insulin-treated patients doing SMBG‡	93	73	62	77 vs. 84	0.255	41	85 vs. 90	0.442
Annual quitting advice to smokers	23	35	—	—	—	—	—	—

Bold values indicate statistical significance. *Only paired data were used for tests, so baseline rates for year 1 and year 2 are a subset of those shown in the first baseline column †Results of logistic regression controlling for physician random effect. ‡Guideline applied to subjects aged ≤ 75 years.

cant improvements in blood pressure monitoring (70 vs. 92%) and comprehensive foot examinations (22 vs. 47%) were seen again. The year 1 improvements in PCP eye exams, eye exam referrals, and glycohemoglobin monitoring were not sustained, with adherence rates reverting to near the baseline levels. Areas of adherence that had not improved at year 1 remained at baseline levels.

Changes in physiologic variables were examined between baseline and year 2. Blood pressure values were available on 98% of patients on whom chart audits were done at both baseline and year 2, but only 39% of patients in both audits had HbA_{1c} data available, and only 28% had lipid profile values. There were no statistically significant improvements in glycohemoglobin or in mean systolic or mean diastolic blood pressure. However, median LDL cholesterol improved from 127 to 111 mg/dl ($P = 0.011$).

CONCLUSIONS— Our finding of low levels of adherence by PCPs to a broad array of diabetes guidelines is consistent with findings by other researchers (2–17). Prior studies have demonstrated successful interventions to improve adherence to diabetes guidelines by PCPs. For example, we showed that reminders programmed into a computerized medical record system improved rates of ophthalmology referral, HbA_{1c} measurement, and nephropathy screening in an academic primary care clinic (29). Demakis et al. (26) demonstrated similar benefits from computerized reminders in Veterans Affairs ambulatory care clinics staffed by resident physicians. Peters and Davidson

(28) significantly improved HbA_{1c} levels, rates of foot and retinal exams, and frequency of laboratory testing in a managed care setting. Their intervention consisted of a computerized tracking and recall system and patient follow-up by nurses who utilized protocols. Similarly, Clark et al. (30) showed striking improvements in physiologic measures (blood pressure, lipids, and HbA_{1c}), process measures, and satisfaction with care in a managed care system through use of a multifaceted intervention that included an enhanced data management system, use of nonphysician providers to perform some examinations, and use of protocols and standing orders.

Successful interventions seem to have in common several permissive factors. First, they occur in “closed” systems with standard processes for scheduling, recordkeeping, and carrying out orders. Second, there is generally a hierarchy such that all physicians are influenced by mandates or incentives for improvement. Removing “routine” aspects of care (ordering laboratory studies, referring patients to eye care professionals) from the purview of busy PCPs and allowing nurses or others to be responsible for these behaviors seems to benefit patient care. Finally, information systems can track data, identify high-risk patients, provide reminders, generate standing orders, and track outcomes far more efficiently than paper charts and busy physicians.

Although managed care and very large group practices are increasingly common, physicians in many areas of the country, including the rural Midwest, continue to

practice independently with low levels of clinical support and without use of computer systems for patient care. We describe a “real-life” intervention to improve diabetes care by a group of such PCPs that met with mixed success. Promising improvements in five of eight areas were seen in the first year, when there was a high level of awareness by the PCPs of the guidelines and of their baseline suboptimal performance. However, these changes were not well maintained over time, despite labor-intensive and varied interventions targeted at multiple arenas (PCPs, patients, and the health care system).

There are several possible explanations for the lack of sustained effects in most areas. One is that we were unable to effectively assess the “dose” of the intervention delivered. In general, we provided multiple tools but could not mandate use of the tools by either physicians or patients. For example, because we were blinded to audited patients’ identities, we did not know whether audited patients attended the patient educational sessions and could not correlate attendance with subsequent measures of diabetes care. Similarly, we know that use of computerized nutritional support was initially popular but then declined in frequency, but we do not know whether or how often patients whose charts were audited used the service.

A second possibility is that with the loss of patients from each audit period, we may have lost statistical power to detect improvements. However, examination of the magnitude of change in nonsignificant comparisons did not suggest this; the absolute proportions were quite similar.

Other possibilities are that the feedback process lost its power to motivate physicians, or that physicians became complacent in year 2 after seeing the improvements that had occurred in year 1.

Our impression, based on targeted interviews with each PCP at the end of the project, is that physicians continued to recognize the importance of the guidelines, but that with time the large barriers to adherence again overcame the initial forces for change. The primary barrier identified by physicians in the interviews was their perception that patients would not comply with recommendations based on some of the intermediate outcomes of the study. For example, PCPs believed that most patients would not comply with medical nutrition therapy for elevated lipids or with insulin therapy or intensification of insulin therapy for elevated HbA_{1c} values. A second barrier identified by the physicians was lack of time to carry out multiple diabetes interventions in a brief visit, especially in patients with other medical issues to address. A final issue raised was poor resource accessibility, such as the lack of local ophthalmologists and difficulty getting timely communications from optometrists or distant ophthalmologists. In addition, PCPs believed that insurers were increasingly requiring patients to use out-of-town laboratories, rather than the county hospital laboratory. These perceived barriers are remarkably similar to those delineated by Helseth et al. (34) in their survey research with primary care physicians.

It is interesting that the two areas in which we saw sustained improvements (blood pressure measurement and foot examinations) were behaviors controlled or initiated by nonphysician staff who were responsible for blood pressure measurements and for instructing patients to remove their shoes while waiting for the PCP in the exam room. These results are consistent with those of Peters and Davidson (28) and Litzelman (35) and would suggest that interventions targeted at PCP office staff may be more fruitful than those targeted solely at physicians.

The results of our project suggest that changes in diabetes care are difficult to effect in busy primary care environments, especially when physicians work independently (with no one to mandate or reward change) and without computer support for data organization and reminders. Interventions other than those

meant primarily to educate physicians and patients need to be developed and tested. These interventions must target the true barriers that exist, which are less likely to be physician knowledge and more likely to be competing goals that must be addressed in limited time, often with inadequate resources. Increased use of computerized medical records and interventions targeted at nonphysician staff may be most effective.

Acknowledgments—The study was funded by the National Institute for Diabetes and Digestive and Kidney Diseases. Abstracts of portions of the data were presented at the Scientific Sessions of the ADA in 1998, 1999, and 2000.

We are grateful to the primary care physicians and their office staffs for their participation. We thank Dr. Charles Clark for reviewing the manuscript, Dr. Stephanie Kraft for assistance with starting the project, and Dr. Naomi Fineberg and Dr. Emmanuel Lazaridis for assistance with data collection and analyses.

References

- Janes GR: Ambulatory medical care for diabetes. In: *Diabetes in America*. 2nd edition. National Diabetes Data Group, Ed. Bethesda, MD, National Institutes of Health, 1995, p. 541–552
- Marrero DG, Moore PS, Langefeld CD, Golichowski A, Clark CM: The treatment of patients with insulin-requiring diabetes mellitus by primary care physicians. *J Commun Health* 16:259–267, 1991
- Kraft SK, Lazaridis EN, Qiu C, Clark CM, Marrero DG: Screening and treatment of diabetic nephropathy by primary care physicians. *J Gen Intern Med* 14:88–97, 1999
- Jacques CHM, Jones RL, Houts P, Bauer LC, Dwyer KM, Lynch JC, Casale TSM: Reported practice behaviors for medical care of patients with diabetes by primary care physicians in Pennsylvania. *Diabetes Care* 14:712–771, 1991
- Survey of Physician Practice Behaviors Related to the Treatment of People with Diabetes Mellitus. Final report. Washington, DC, National Institute of Diabetes and Digestive and Kidney Diseases, 1990
- Michigan Diabetes Research and Training Center and Department of Postgraduate Medicine and Health Professional Education: *Diabetes in Communities II*. Ann Arbor, MI, University of Michigan Medical School, 1992
- Marrero DG, Moore PS, Langefeld CD, Golichowski A, Clark CM: Care of diabetic pregnant women by primary care physicians. *Diabetes Care* 13:101–107, 1992
- Kenny SJ, Smith PJ, Goldschmid MG, Newman JM, Herman WH: Survey of physician practice behaviors related to diabetes mellitus in the U.S.: physician adherence to consensus recommendations. *Diabetes Care* 16:1507–1510, 1993
- Tuttleman M, Lipsett L, Harris MI: Attitudes and behaviors of primary care physicians regarding tight control of blood glucose in IDDM patients. *Diabetes Care* 16:765–772, 1993
- Zoorob RJ, Mainous AG: Practice patterns of rural family physicians based on the American Diabetes Association standards of care. *J Commun Health* 21:175–182, 1996
- Marshall CL, Bluestein M, Chapin C, Davis T, Gersten J, Harris C, Hodgins A, Larsen W, Rigberg H, Krishnaswami V, Darling B: Outpatient management of diabetes mellitus in five Arizona Medicare managed care plans. *Am J Med Qual* 11: 87–93, 1996
- Peters AL, Ossorio RC, Legorreta AP, Davidson MB: Quality of outpatient care provided to diabetic patients: a health maintenance organization experience. *Diabetes Care* 19:601–606, 1996
- Martin TL, Zhang D, Selby JV: Physician and patient prevention practices in NIDDM in a large urban managed-care organization. *Diabetes Care* 18:1124–1132, 1995
- Ho M, Marger M, Beart J, Yip I, Shekelle P: Is the quality of diabetes care better in a diabetes clinic or a general medicine clinic? *Diabetes Care* 20:472–475, 1997
- Weiner JP, Parente ST, Garnick DW, Fowles J, Lawthers AG, Palmer RH: Variation in office-based quality: a claims-based profile of care provided to Medicare patients with diabetes. *JAMA* 273:1503–1508, 1995
- Jencks SF, Cuerdon T, Burwen DR, Fleming B, Houck PM, Kussmaul AE, Nilasena DS, Ordin DL, Arday DR: Quality of medical care delivered to Medicare beneficiaries: a profile at state and local levels. *JAMA* 284:1670–1676, 2000
- Beckles GLA, Engelgau MM, Narayan KMV, Herman WH, Aubert RE, Williamson DF: Population-based assessment of the level of care among adults with diabetes in the U.S. *Diabetes Care* 21:1432–1438, 1998
- Tunis SR, Hayward RS, Wilson MC, Rubin HR, Bass EB, Johnston M, Steinberg EP: Internists' attitudes about clinical practice guidelines. *Ann Intern Med* 120: 956–963, 1994
- Ackermann SP, Cheal N: Factors affecting physician adherence to breast cancer screening guidelines. *J Cancer Educ* 9:96–100, 1994
- Marrero DG, Kraft SK, Mayfield J,

- Wheeler ML, Fineberg N: Nutrition management of type 2 diabetes by primary care physicians: reported uses and barriers. *J Gen Intern Med* 15:818–821, 2000
21. Drass J, Kell S, Osborn M, Bausell B, Corcoran J, Moscovitz A, Fleming B: Diabetes care for Medicare beneficiaries: attitudes and behaviors of primary care physicians. *Diabetes Care* 21:1282–1287, 1998
 22. Litzelman DK, Tierney WM: Physicians' reasons for failing to comply with computerized preventive care guidelines. *J Gen Intern Med* 11:497–499, 1996
 23. Marrero DG: Current effectiveness of diabetes health care in the U.S.: how far from ideal? *Diabetes Rev* 2:292–309, 1994
 24. Feder G, Griffiths C, Highton C, Eldridge S, Spence M, Southgate L: Do clinical guidelines introduced with practice based education improve care of asthmatic and diabetic patients? *BMJ* 311:1473–1478, 1995
 25. Goldfracht M, Porath A: Nationwide program for improving the care of diabetic patients in Israeli primary care centers. *Diabetes Care* 23:495–499, 2000
 26. Demakis JG, Beauchamp C, Cull WL, Denwood R, Eisen SA, Lofgren R, Nichol K, Woolliscroft J, Henderson WG: Improving residents' compliance with standards of ambulatory care: results from a VA Cooperative Study on computerized reminders. *JAMA* 284:1411–1416, 2000
 27. Sadur CN, Moline N, Costa M, Michalik D, Mendlowitz D, Roller S, Watson R, Swain BE, Selby JV, Javorski WC: Diabetes management in a health maintenance organization: efficacy of care management using cluster visits. *Diabetes Care* 22:2011–2017, 1999
 28. Peters AL, Davidson MB: Application of a diabetes managed care program: the feasibility of using nurses and a computer system to provide effective care. *Diabetes Care* 21:1037–1043, 1998
 29. Kirkman MS, Marrero DG, Tierney WM: Computerized reminders increase adherence to diabetes care guidelines by primary care physicians (Abstract). *Diabetes* 48:A194, 1999
 30. Clark CM, Snyder JW, Meek RL, Stutz LM, Parkin CG: A systematic approach to risk stratification and intervention within a managed care environment improves diabetes outcomes and patient satisfaction. *Diabetes Care* 24:1079–1086, 2001
 31. County profile, Census 2000 data: Available from <http://www.stats.indiana.edu>. Accessed September 2, 2002
 32. American Diabetes Association: Standards of medical care for patients with diabetes mellitus. *Diabetes Care* 20:S5–S13, 1997
 33. Mazza SA, Moorman NH, Wheeler ML, Norton JA, Fineberg NS, Vinicor F, Cohen SJ, Clark CM: The diabetes education study: a controlled trial of the effects of diabetes patient education. *Diabetes Care* 9:1–10, 1986
 34. Helseth LD, Susman JL, Crabtree BF, O'Connor PJ: Primary care physicians' perceptions of diabetes management: a balancing act. *J Fam Pract* 48:37–42, 1999
 35. Litzelman DK, Slemenda CW, Langefeld CD, Hayes LM, Welch MA, Bild DE, Ford ES, Vinicor F: Reduction of lower extremity clinical abnormalities in patients with non-insulin-dependent diabetes mellitus: a randomized, controlled trial. *Ann Intern Med* 119:36–41, 1993