

Effective Diabetes Care by a Registered Nurse Following Treatment Algorithms in a Minority Population

Mayer B. Davidson, MD; Maria Castellanos, RN; Petra Duran, BS;
and Vicki Karlan, MPH

Objective: To compare usual care with nurse-directed care for patients with diabetes.

Study Design: Randomized before-after trial.

Methods: Diabetic patients were randomly selected for a diabetes managed care program (DMCP), in which a specially trained registered nurse, supervised by an endocrinologist, followed detailed treatment algorithms. Process and outcome measures during the year before DMCP entry were compared with those during the first year of DMCP enrollment.

Results: A total of 367 patients completed a full year in the DMCP. Data from the prior year were available for 331 patients. Among a subset of Latino patients, 95% earned less than \$25 000 and 73% had an education of 6th grade or less. Process measures recommended by the American Diabetes Association (ADA) were met 98% of the time during the DMCP year compared with 54% of the time during the prior year ($P < .001$). Mean glycosylated hemoglobin (A1C) levels fell from 9.3% to 8.7% in the year before entry into the DMCP and to 7.0% by the end of the first DMCP year ($P < .001$). At DMCP entry, 28% met the ADA A1C goal of $<7\%$; 60% did so at the end of the year. Fifty-one percent met the ADA low-density lipoprotein cholesterol goal at entry into the DMCP compared with 82% at the end of the year.

Conclusion: A nurse making clinical decisions based on detailed treatment algorithms did a better job of achieving ADA-recommended process and outcome measures than physicians providing usual care.

(*Am J Manag Care. 2006;12:226-232*)

Although evidence-based guidelines that will improve diabetes outcomes have been promulgated by the American Diabetes Association (ADA), most patients do not meet the recommended goals. In the 1990s, the average glycosylated hemoglobin (A1C) level was 9.5%.¹ Furthermore, the easier-to-meet process measures of A1C testing, determination of low-density lipoprotein (LDL) cholesterol and triglyceride levels, testing for microalbuminuria, doing routine urinalyses for protein, and performing eye and foot examinations fell far short of the ADA guidelines that were in force at the time of the 1997 review.¹ Although there have been improvements, outcomes are still sub-optimal. Subsequent studies in more than 14 000 diabetic patients published after the 1997 review revealed a decrease in the average A1C level to 8.6%, better but still far above the ADA goal of $<7.0\%$.^{2,3} A1C levels of

$>9.5\%$ were still seen in 21% to 43% of patients.²⁻⁴ Only 3% to 10% of diabetic patients met the combined ADA goals for glycemia, lipids, and blood pressure.^{3,5,6} The process measures also were being done far less frequently than the ADA guidelines recommended.

Most approaches to improving diabetes outcome measures have not been very effective. These include (1) reminding patients about appointments^{7,8}; (2) giving the physician feedback on the patient,⁹⁻¹² even when treatment recommendations for the patient were included^{13,14}; (3) case management (when the case manager could not make treatment decisions)^{15,16}; and (4) multifaceted quality improvement interventions in the practice setting.^{17,18} One study of intensive education for physician residents did show an improvement in patient A1C levels compared with the control group,¹⁹ but 2 other studies showed no benefit.^{20,21}

Knight et al recently published a systematic review and meta-analysis assessing the effects of diabetes disease management programs in this *Journal*.²² They concluded that these kinds of programs showed a "modest" effect on glycemic control, with a statistically significant decrease in A1C levels of 0.5% (95% confidence interval of 0.3%-0.6%). However, only one study utilizing nurses making treatment decisions was included.²³ The present study demonstrates that a nurse following detailed treatment algorithms (and supervised by an endocrinologist) had a much greater effect, even though most of the patients were poor and poorly educated members of minority groups.

METHODS

Patients with diabetes from a county-sponsored community clinic were randomly selected from the

From Charles R. Drew University, Los Angeles, Calif (MBD, MC, PD); and Pfizer Health Solutions, Inc, Santa Monica, Calif (VK).

This study was funded by the American Diabetes Association, Pfizer Health Solutions, Inc, and Merck & Co Inc. Dr. Davidson was supported by National Institutes of Health grant U54-RR014616.

Address correspondence to: Mayer B. Davidson, MD, Charles R. Drew University, 1731 East 120th St, Los Angeles, CA 90059. E-mail: madavids@cdrewu.edu.

adult medical clinics. Patients who agreed to participate were enrolled in a diabetes managed care program (DMCP). Their process and outcome measures during the year before entering the DMCP were compared with those after 1 year of enrollment. Diabetes care in the DMCP was delivered by a specially trained nurse following detailed diabetes treatment algorithms and supervised by one of the authors (MBD), who is an endocrinologist. The endocrinologist met with the nurse once a week but was available by phone at all other times. Treatment guidelines were based on ADA recommendations (Table 1). During the first year of this 3-year study, the LDL cholesterol goal was <130 mg/dL, which was changed by the ADA to <100 mg/dL during the last 2 years.

The algorithms for glycemic control included those for diet therapy alone; sulfonylurea agents and metformin, either alone or in combination; a glitazone added to maximal (tolerated) dose of metformin plus a sulfonylurea agent; bedtime isophane insulin (NPH) plus daytime oral antihyperglycemic drugs; and a split-mixed insulin regimen with NPH and regular insulin. There also were algorithms and protocols for evaluating and managing lipid disorders, evaluating nephropathy, and treating microalbuminuria. For patients controlling their diabetes by diet and exercise alone or by taking pills (without insulin), the A1C goal was <7.0%, the level recommended by the ADA. However, an A1C value of >7.5% was used to make the decision to add bedtime insulin or to switch from that regimen to mul-

iple injections of insulin, because these changes entailed large adjustments in lifestyle. Studies in more than 2000 patients followed for 6 to 9 years showed that although development or progression of diabetic retinopathy and nephropathy was virtually absent with mean A1C levels of <7.0%, development or progression was only mild with average values between 7% and 8%.²⁴⁻²⁸

At the conclusion of the study, charts were abstracted to determine the process and outcomes of care. Process measures were frequency of testing for A1C, LDL cholesterol, and triglycerides; evaluation for microalbuminuria and clinical proteinuria; number of visits; and recorded eye and foot examinations. Outcome measures were A1C levels, percentage of patients meeting ADA goals for A1C and LDL cholesterol, and treatment of microalbuminuria or clinical proteinuria with an angiotensin-converting enzyme (ACE) inhibitor or an angiotensin receptor blocker (ARB).

The collected demographic data also included education and income levels in a subset of Latino patients. Independent *t* tests were performed to compare baseline clinical values between groups. Categorical demographic data, process measures, treatment types, and percentage of patients who met clinical goals were analyzed by using χ^2 tests. Paired *t* tests were used to compare clinical values and number of tests performed during the intervention and prior year. The Wilcoxon signed rank test was used to compare median values of A1C levels. All data analyses were conducted with SPSS version

Table 1. Treatment Guidelines Based on Recommendations of the American Diabetes Association

Guideline	Frequency	Goal or Treatment
Measurement of A1C	Every 6 months if goal attained Every 3 months if above goal	<7.0%
LDL cholesterol	Yearly or more often as necessary	<100 mg/dL
Renal profile Dipstick test for proteinuria	Yearly or more often as necessary	If ≥ 1 ,* ACE inhibitor unless contraindicated If negative or trace, evaluation for microalbuminuria
Microalbuminuria		If positive [†] and confirmed, ACE inhibitor unless contraindicated
Eye examination	Yearly dilated fundoscopic exam	
Foot examination	Minimum every 6 months	

A1C indicates glycosylated hemoglobin; ACE, angiotensin-converting enzyme; LDL, low-density lipoprotein.

*With infection and menstrual bleeding ruled out.

[†]Either an albumin/creatinine ratio of >30 $\mu\text{g}/\text{mg}$ or an albumin concentration of >20 $\mu\text{g}/\text{L}$.

Source: American Diabetes Association: Clinical Practice Recommendations 2006. *Diabetes Care*. 2006;29:S4-S42.

12.0 (SPSS Inc, Chicago, IL). Statistical significance was considered to be $P < 0.05$.

RESULTS

The numbers of patients recruited and retained in the DMCP are shown in **Figure 1**. Eighty-one who signed the consent form did not show up to the initial clinical visit with the nurse in spite of several reminders by phone and letter. Of the 460 patients who entered the DMCP, 367 (80%) completed a year-long intervention. In addition to belonging to a transient population, many Mexican Americans return to Mexico for extended periods, especially around Christmas and the New Year. Because 87.5% of the change in A1C levels occurs within 3 months,^{29,30} patients who were absent for that amount of time were disenrolled from the study because their A1C level would not reflect treatment in the DMCP. Among the 93 disenrolled patients, the reasons for disenrollment were as follows: no contact for 3 months in spite of numerous attempts to reach them ($n = 45$); voluntary program withdrawal ($n = 34$); patient moved away ($n = 9$); change of health plans ($n = 3$); and pregnancy ($n = 2$). Preliminary data on the first 114 patients to complete the DMCP were published previously.³¹

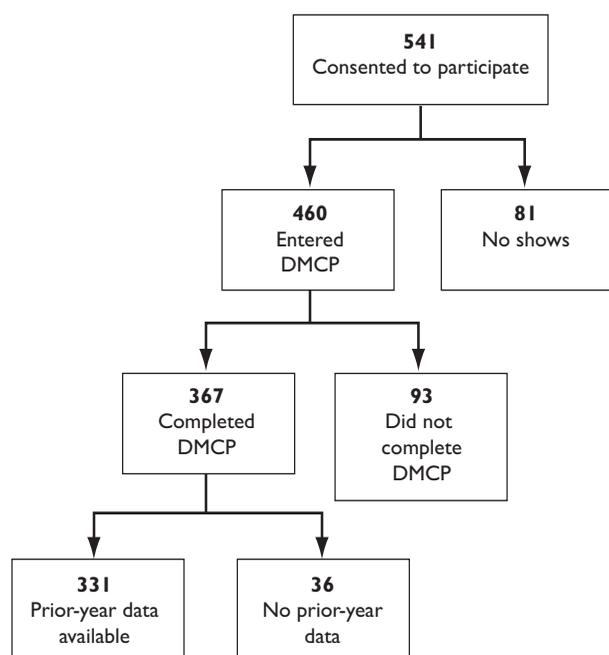
Patients who completed the DMCP and patients who were disenrolled had similar baseline characteristics, except for a higher percent of females in the latter group (**Table 2**). A subset ($n = 109$) of Latino patients enrolled in the final year of this 3-year study were queried concerning their education and income levels. Because these are sensitive questions, not all patients answered them. Of the 63 patients who responded to the question concerning annual household income, 60 (95%) earned less than \$25 000 per year. Of the 102 who responded to the question concerning their level of formal education, 74 (73%) had a 6th grade education or less.

The process measures achieved during the year before entering the DMCP and subsequently under nurse-directed care in the DMCP are shown in **Table 3**. There were no data for 36 patients for the year prior to entering the study. This was because they either had new-onset diabetes, were new to the county clinic, or their charts were lost. Compared with the process measures in the prior year, all of the process measures listed in **Table 3** were done significantly more often in the DMCP. Overall, these process measures were met 54% of the time during the year before entry into the DMCP and 98% of the time during the first DMCP year ($P < .001$). Patients were only followed for 1 year, at which time they returned to their physician for their diabetes care.

During the year before entering the DMCP, 233 patients of the 282 tested with a dipstick for proteinuria had negative or trace results. Of these 233, 156 (67%) underwent testing for microalbuminuria. During the year of enrollment in the DMCP, 283 of the 345 tested with a dipstick for proteinuria had negative or trace results. Of these 283, 264 (93%) underwent testing for microalbuminuria, a significantly ($P < .001$) higher percentage than that under usual care. During the year before entering the DMCP, 241 patients had either clinical proteinuria (dipstick $\geq 1+$) or microalbuminuria; 155 (64%) of these patients received either an ACE inhibitor or an ARB. During the first year in the DMCP, 280 patients had either clinical proteinuria or microalbuminuria, and 219 (78%) received either an ACE inhibitor or an ARB, a significantly ($P < .001$) higher percentage than those under usual care.

The A1C results are shown in **Figure 2**. During the year before entering the DMCP, 303 patients had at least 1 test for A1C. In the DMCP, all patients had at least 1 test, but 3 did not have a follow-up test. Three patients had a hemoglobinopathy, which meant that their values were not valid. Because the A1C test used at entry into the DMCP was also used as the A1C test at the end of the prior year, a change for all 303 patients under usual care

Figure 1. Patient Participation in a DMCP



DMCP indicates diabetes managed care program.

could be calculated. The initial mean value of 9.3% fell to 8.7%, a change of $-0.6\% \pm 2.8\%$. Even though the A1C was lower at entry into the DMCP than at the beginning of the year before entry, the decrease achieved in 361 patients during the DMCP year was 3-fold greater, from an initial value of 8.8% to 7.0% for a change of $-1.8\% \pm 2.6\%$ ($P < .001$ compared with the decrease in the year before entry). The median A1C levels fell from 8.8% at the beginning of the year before entering the DMCP to 8.4% at DMCP entry to 6.7% at the end of the year in the DMCP. The percentage of patients who met the ADA A1C goal of $<7.0\%$ at the beginning of the year before entering the DMCP was 17%, which increased to 28% at the time of entry into the DMCP. At the end of the year in the DMCP, 60% met that goal.

The percentage of patients who met the LDL cholesterol goal at the beginning of the year before entry into the DMCP was 51%, which remained essentially unchanged at 50% when the patients enrolled in the DMCP. However, after a year in the DMCP, 82% met the LDL cholesterol goal.

DISCUSSION

Providing information to the physician has been the cornerstone of most approaches to improving diabetes care. The following study illustrates the limitations of simply giving the healthcare provider feedback about the patient's condition to improve outcomes.⁹ Eight agreed-on process measures and whether the patient was due to receive them were displayed on the physician's computer screen at the time the patient was in the office. However, these measures were performed or ordered only one third of the time. Physicians pinpointed lack of time and other conditions that needed attention as the primary obstacles to carrying out the recommendations.

In contrast, an endocrinologist-supervised nurse who followed treatment algorithms markedly improved outcomes compared with the usual physician-directed care that the patients received during the year before enter-

Table 2. Baseline Characteristics of Patients Entering the DMCP

Characteristic	Patients Completing the Program	Disenrolled Patients
No. of patients	367	93
Mean (SD) age, y	51.2 (10.7)	51.8 (12.5)
Mean (SD) duration of diabetes, y	6.9 (6.6)	8.2 (7.8)
Female, %	71*	81*
Race/ethnicity, n (%)		
African American	80 (22)	25 (27)
Latino	283 (77)	68 (73)
Caucasian	2 (0.5)	—
Asian	2 (0.5)	—
Type 1 diabetes, n (%)	2 (0.5)	2 (2)
Type 2 diabetes, n (%)	365 (99.5)	91 (98)
Mean (SD) A1C, %	8.8 (2.5) [†]	9.2 (2.6)
Mean (SD) lipid profile		
Total cholesterol, mg/dL	197 (43)	202 (37)
LDL cholesterol, mg/dL	123 (39)	126 (33)
Triglycerides	188 (145)	187 (118)

SD indicates standard deviation; A1C, glycosylated hemoglobin; DMCP, diabetes managed care program; LDL, low-density lipoprotein.

* $P < .05$.

[†]Three patients had a hemoglobinopathy (n = 364).

ing the DMCP. In the DMCP, there was nearly 100% compliance with the ADA-recommended process measures. Outcome measures were close to the ADA guidelines: the mean A1C level was 7.0%, the median A1C level was 6.7%, 60% met the A1C goal of $<7.0\%$, and 82% met the LDL cholesterol goal. (Blood pressure management was not part of these treatment algorithms.) These results are perhaps all the more remarkable because these patients were poor and poorly educated members of minority populations—attributes that typically lead to worse outcomes.³²⁻³⁴ However, they confirm other studies in which nurses³⁵⁻⁴⁴ and pharmacists⁴⁵⁻⁴⁷ following treatment algorithms produced significantly better outcomes than those achieved with physician-directed care. Patients followed by nurses developed significantly less diabetic retinopathy over 2 years than a control group receiving usual care.⁴⁸

So why do specially trained nurses and pharmacists following treatment algorithms routinely improve care while providers using other approaches do not? According to a National Institutes of Health request for

Table 3. Process Measures of Diabetes Care*

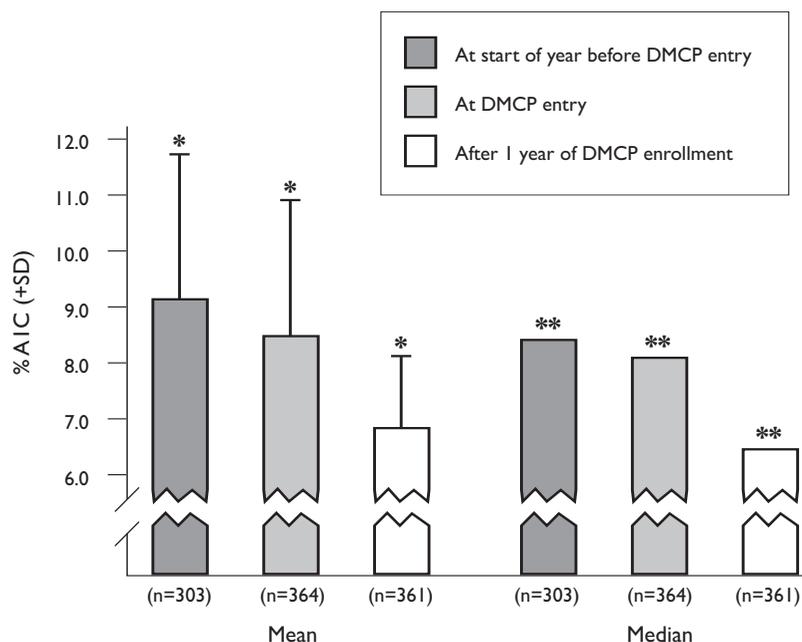
Measure	No. of Patients (%)		P
	Usual Care	Nurse-directed Care	
Two or more visits per year	248/331 (75)	363/367 (99)	<.001
Diabetes education	32/331 (10)	367/367 (100)	<.001
Nutritional counseling	3/331 (1)	366/367 (~100)	<.001
Two or more foot exams per year	248/331 (75)	363/367 (99)	<.001
Referral for eye exam	195/331 (59)	365/367 (~100)	<.001
Documented eye exam	139/331 (42)	335/367 (91)	<.001
Two or more A1C tests per year [†]	217/331 (66)	364/367 (99)	<.001
One or more lipid profiles per year	244/331 (74)	366/367 (~100)	<.001
One or more albuminuria tests per year	289/331 (87)	359/367 (98)	<.001

A1C indicates glycosylated hemoglobin.

*Process measures for usual care were done during the year before entry into the diabetes managed care program (DMCP). Process measures for nurse-directed care were done during the year of DMCP enrollment.

[†]At least 1 test in each 6-month period.

Figure 2. A1C Levels at Beginning and End of the Year Before DMCP Entry and at End of 1 Year in the DMCP



A1C indicates glycosylated hemoglobin; DMCP, diabetes managed care program; SD, standard deviation.

*P < .001 for comparisons similarly marked with a single or a double asterisk.

proposals,⁴⁹ there are a number of barriers to delivering good patient care. These include (1) healthcare provider knowledge; (2) communication between patient and healthcare provider; (3) attitudes and beliefs of the patient, community/culture, healthcare provider, and healthcare system; (4) racial and ethnic disparities; (5) variations in settings, including the healthcare system; (6) clinical traditions; (7) socioeconomic status; and (8) cost. The treatment algorithms surmount the first barrier because they are written by specialists. In addition, nurses and pharmacists are likely to be able to communicate more effectively with patients for several reasons. They often are more likely than the physician to be part of the local community. Therefore, they are more cognizant of the attitudes and beliefs that must be taken into account in delivering the care and involving patients in management of their condition. Even more important, because they are not responsible for

other patient problems, they have more time to devote to diabetes care than the usual harried physician who has more patients to see and a wider scope of problems with which to deal. A major reason for the improved outcomes in the DMCP was the appropriate, timely clinical decisions made by the nurse, rather than decisions made as the result of a patient-provider interaction every 3 months or so.

Most diabetes care involves efforts to prevent complications by lowering A1C, lipid, and blood pressure levels; ensuring examination of eyes and feet; and monitoring of renal function for possible treatment of microalbuminuria. The acute-care model in which physicians practice in our current medical care system is not well suited to deliver effective preventive care. As this article and others have shown, nurses^{23,31,35-44,48} and pharmacists⁴⁵⁻⁴⁷ who follow approved protocols and are supervised appropriately can deliver more effective diabetes care. Although there may be some increased initial costs with this approach (eg, adding nurses, more drugs for treatment), there will certainly be subsequent cost savings.⁵⁰⁻⁵² Policymakers who seek to improve diabetes care should seriously consider this approach.

REFERENCES

- Davidson MB. Diabetes care in health maintenance organization and fee-for-service settings. *Dis Manage Health Outcomes*. 1997;2:189-197.
- Davidson MB. The case for "outsourcing" diabetes care. *Diabetes Care*. 2003;26:1608-1612.
- Saydeh SH, Fradkin J, Cowie CC. Poor control of risk factors for vascular disease among adults with previously diagnosed diabetes. *JAMA*. 2004;291:335-342.
- Suwattee P, Lynch JC, Pendergrass ML. Quality of care for diabetic patients in a large urban public hospital. *Diabetes Care*. 2003;26:563-568.
- McFarlane SI, Jacober SJ, Winer N, et al. Control of cardiovascular risk factors in patients with diabetes and hypertension at urban academic medical centers. *Diabetes Care*. 2002;25:718-723.
- Grant RW, Buse JB, Meigs JB, et al. Quality of diabetes care in US academic medical centers. *Diabetes Care*. 2005;28:337-442.
- Piette JD, Weinberger MD, Kraemer FB, McPhee SJ. Impact of automated calls with nurse follow-up on diabetes treatment outcomes in a Department of Veterans Affairs Health Care System; a randomized controlled trial. *Diabetes Care*. 2001;24:202-208.
- Shandro MT, Pick ME, Gruninger A, Ryan EA. Diabetes care: interventions in the community. *Diabetes Care*. 2002;25:941.
- Lobach DF, Hammond WE. Computerized decision support based on a clinical practice guideline improves compliance with care standards. *Am J Med*. 1997;102:89-98.
- Deichmann RE, Castello E, Horswell R, Friday KE. Improvements in diabetic care as measured by Hb A1C after a physician education project. *Diabetes Care*. 1999;22:1612-1616.
- Petitti DB, Contreras R, Ziel FH, Dudl J, Domurat ES, Hyatt JA. Evaluation of the effect of performance monitoring and feedback on care process, utilization, and outcome. *Diabetes Care*. 2000;23:192-196.
- Demakis JG, Beauchamp C, Cull WL, et al. Improving residents' compliance with standards of ambulatory care: results from the VA Cooperative Study on Computerized Reminders. *JAMA*. 2000;284:1411-1416.
- Ilag LL, Martin CL, Tabei BP, et al. Improving diabetes processes of care in managed care. *Diabetes Care*. 2003;26:2722-2727.
- Grant RW, Cagliero E, Sullivan CM, et al. A controlled trial of population management; diabetes mellitus: putting evidence into practice (DM-PEP). *Diabetes Care*. 2004;27:2299-2305.
- Krein SL, Klamerus ML, Vijan S, et al. Case management for patients with poorly controlled diabetes: a randomized trial. *Am J Med*. 2004;116:732-739.
- Glasgow RE, Nutting PA, King DK, et al. Randomized effectiveness trial of a computer-assisted intervention to improve diabetes care. *Diabetes Care*. 2005;28:33-39.
- Majumdar SR, Guirguis LM, Toth EL, Lewanczuk RZ, Lee TK, Johnson JA. Controlled trial of a multifaceted intervention for improving quality of care for rural patients with type 2 diabetes. *Diabetes Care*. 2003;26:3061-3066.
- Chin MH, Cook S, Drum ML, et al. Improving diabetes care in Midwest community health centers with the health disparities collaborative. *Diabetes Care*. 2004;27:2-8.
- Benjamin EM, Schneider MS, Hinchey KT. Implementing practice guidelines for diabetes care using problem-based learning: a prospective controlled trial using firm systems. *Diabetes Care*. 1999;22:1672-1678.
- Kirkman MS, Williams SR, Caffrey HA, Marrero DG. Impact of a program to improve adherence to diabetes guidelines by primary care physicians. *Diabetes Care*. 2002;25:1946-1951.
- Hirsch IB, Goldberg HI, Ellsworth A, et al. A multifaceted intervention in support of diabetes treatment guidelines: a controlled trial. *Diab Res Clin Pract*. 2002;58:27-36.
- Knight K, Badamgarav E, Henning JM, et al. A systematic review of diabetes disease management programs. *Am J Manag Care*. 2005;11:242-250.
- Aubert RE, Herman WH, Waters J, et al. Nurse case management to improve glycemic control in diabetic patients in a health maintenance organization. A randomized, controlled trial. *Ann Intern Med*. 1998;129:605-612.
- The DCCT Research Group. The relationship of glycemic exposure (HbA1c) to the risk of development and progression of retinopathy in the diabetes control and complications trial. *Diabetes*. 1995;44:968-983.
- Ohkubo Y, Kishikawa H, Araki E, et al. Intensive insulin therapy prevents the progression of diabetic microvascular complications in Japanese patients with non-insulin-dependent diabetes mellitus: a randomized prospective 6-year study. *Diabetes Res Clin Pract*. 1995;28:103-117.
- Krolewski AS, Laffel LM, Krolewski M, Quinn M, Warram JH. Glycosylated hemoglobin and the risk of microalbuminuria in patients with insulin-dependent diabetes mellitus. *N Engl J Med*. 1995;332:1251-1255.
- Tanaka Y, Atsumi Y, Matsuoka K, Onuma T, Tohijima T, Kawamori R. Role of glycemic control and blood pressure in the development and progression of nephropathy in elderly Japanese NIDDM patients. *Diabetes Care*. 1998;21:116-120.
- Warram JH, Scott LJ, Hanna LS, et al. Progression of microalbuminuria to proteinuria in type 1 diabetes: nonlinear relationship with hyperglycemia. *Diabetes*. 2000;49:94-100.
- Tahara Y, Shima K. The response of GHb to stepwise plasma glucose change over time in diabetic patients. *Diabetes Care*. 1993;16:1313-1314.
- Tahara Y, Shima K. Kinetics of HbA1c, glycated albumin, and fructosamine and analysis of their weight functions against preceding plasma glucose level. *Diabetes Care*. 1995;18:440-447.
- Davidson MB. Effect of nurse-directed diabetes care in a minority population. *Diabetes Care*. 2003;26:2281-2287.
- Rothman RL, DeWalt DA, Malone R, et al. Influence of patient literacy on the effectiveness of a primary care-based diabetes disease management program. *JAMA*. 2004;292:1711-1716.
- Brown AF, Ettner SL, Piette J, et al. Socioeconomic position and health among persons with diabetes mellitus: a conceptual framework and review of the literature. *Epidemiol Rev*. 2004;26:63-77.
- Lanting LC, Joung IMA, MacKenbach JP, Lamberts SWJ, Bootsma AH. Ethnic differences in mortality, end-stage complications, and quality of care among diabetic patients: a review. *Diabetes Care*. 2005;28:2280-2288.
- Legorreta AP, Peters AL, Ossorio C, Lopez RJ, Jatulis D, Davidson MB. Effect of a comprehensive nurse-managed diabetes program: an HMO study. *Am J Manag Care*. 1996;2:1024-1030.
- 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*. 1998;21:1037-1043.
- Sidorov J, Gabbay R, Harris R, et al. Disease management for diabetes mellitus: impact on hemoglobin A1C. *Am J Manag Care*. 2000;6:1217-1226.
- Taylor CB, Miller NH, Reilly KR, et al. Evaluation of a nurse care management system to improve outcomes in patients with complicated diabetes. *Diabetes Care*. 2003;26:1058-1063.
- Polonsky WH, Earles J, Smith S, et al. Integrating medical management with diabetes self-management training: a randomized control trial of the Diabetes Outpatient Intensive Treatment program. *Diabetes Care*. 2003;26:3048-3053.
- Phillis-Tsimikas A, Walker C, Rivard LR, et al. Improvement in diabetes care of underinsured patients enrolled in Project Dulce: a community-based, culturally appropriate, nurse case management and peer education diabetes care model. *Diabetes Care*. 2004;27:110-115.
- The California Medi-Cal Type 2 Diabetes Study Group. Closing the gap: effect of diabetes case management on glycemic control among low-income ethnic minority populations. *Diabetes Care*. 2004;27:95-103.
- Fanning EL, Selwyn BJ, Larme AC, DeFronzo RA. Improving efficacy of diabetes management using treatment algorithms in a mainly Hispanic population. *Diabetes Care*. 2004;27:1638-1646.
- Craig KJ, Donovan K, Munnery M, Owens DR, Williams JD, Philips AO.

MANAGERIAL

Identification and management of diabetic nephropathy in the diabetes clinic. *Diabetes Care*. 2003;26:1806-1811.

44. **New JP, Mason JM, Freemantle N, et al.** Specialist nurse-led intervention to treat and control hypertension and hyperlipidemia in diabetes (SPLINT); a randomized trial. *Diabetes Care*. 2003;26:2250-2255.

45. **Davidson MB, Karlan VJ, Hair TL.** Effect of a pharmacist-managed diabetes care program in a free medical clinic. *Am J Med Qual*. 2000;15:137-142.

46. **Leal S, Glover JJ, Herrier RN, Felix A.** Improving quality of care in diabetes through a comprehensive pharmacist-based disease management program. *Diabetes Care*. 2004;27:2983-2984.

47. **Rothman RL, Malone R, Bryant B, et al.** A randomized trial of a primary care-based disease management program to improve cardiovascular risk factors and glycated hemoglobin levels in patients with diabetes. *Am J Med*. 2005;118:276-284.

48. **Pettit DJ, Wollitzer AO, Jovanovic L, He G, Ipp E.** Decreasing the risk of diabetic retinopathy in a study of case management: the California Med-Cal Type 2 Diabetes Study. *Diabetes Care*. In press.

49. **Translational research for the prevention and control of diabetes [program announcement]**. PA-02-153. Release date: August 22, 2002. Available at: <http://grants2.nih.gov/grants/guide/pa-files/PA-02-153.html>. Accessed March 27, 2006.

50. **Gilmer TP, O'Connor OJ, Manning WG, Rush WA.** The cost to health plans of poor glycemic control. *Diabetes Care*. 1997;20:1847-1853.

51. **Wagner EH, Sandhu N, McCulloch DK, Ramsey SD, Grothaus LC.** Effect of improved glycemic control on health care costs and utilization. *JAMA*. 2001;285:182-189.

52. **Menzin J, Langley-Hawthorne C, Friedman M, Boulanger L, Cavanaugh R.** Potential short-term economic benefits of improved glycemic control: a managed care perspective. *Diabetes Care*. 2001;24:51-55.