

Does Diabetes Disease Management Save Money and Improve Outcomes?

A report of simultaneous short-term savings and quality improvement associated with a health maintenance organization–sponsored disease management program among patients fulfilling health employer data and information set criteria

JAAN SIDOROV, MD, FACP, CMCE¹
ROBERT SHULL, PHD¹
JANET TOMCAVAGE, RN, MSN, CDE¹

SABRINA GIROLAMI, RN, BSN¹
NADINE LAWTON, RN²
RONALD HARRIS, MD, FACE¹

OBJECTIVE— Little is known about the impact of disease management programs on medical costs for patients with diabetes. This study compared health care costs for patients who fulfilled health employer data and information set (HEDIS) criteria for diabetes and were in a health maintenance organization (HMO)-sponsored disease management program with costs for those not in disease management.

RESEARCH DESIGN AND METHODS— We retrospectively examined paid health care claims and other measures of health care use over 2 years among 6,799 continuously enrolled Geisinger Health Plan patients who fulfilled HEDIS criteria for diabetes. Two groups were compared: those who were enrolled in an opt-in disease management program and those who were not enrolled. We also compared HEDIS data on HbA_{1c} testing, percent not in control, lipid testing, diabetic eye screening, and kidney disease screening. All HEDIS measures were based on a hybrid method of claims and chart audits, except for percent not in control, which was based on chart audits only.

RESULTS— Of 6,799 patients fulfilling HEDIS criteria for the diagnosis of diabetes, 3,118 (45.9%) patients were enrolled in a disease management program (program), and 3,681 (54.1%) were not enrolled (nonprogram). Both groups had similar male-to-female ratios, and the program patients were 1.4 years younger than the nonprogram patients. Per member per month paid claims averaged \$394.62 for program patients compared with \$502.48 for nonprogram patients ($P < 0.05$). This difference was accompanied by lower inpatient health care use in program patients (mean of 0.12 admissions per patient per year and 0.56 inpatient days per patient per year) than in nonprogram patients (0.16 and 0.98, $P < 0.05$ for both measures). Program patients experienced fewer emergency room visits (0.49 per member per year) than nonprogram patients (0.56) but had a higher number of primary care visits (8.36 vs. 7.78, $P < 0.05$ for both measures). Except for emergency room visits, these differences remained statistically significant after controlling for age, sex, HMO enrollment duration, presence of a pharmacy benefit, and insurance type. Program patients also achieved higher HEDIS scores for HbA_{1c} testing as well as for lipid, eye, and kidney screenings (96.6, 91.1, 79.1, and 68.5% among program patients versus 83.8, 77.6, 64.9, and 39.3% among nonprogram patients, $P < 0.05$ for all measures). Among 1,074 patients with HbA_{1c} levels measured in a HEDIS chart audit, 35 of

526 (6.7%) program patients had a level $>9.5\%$, as compared with 79 of 548 (14.4%) nonprogram patients.

CONCLUSIONS— In this HMO, an opt-in disease management program appeared to be associated with a significant reduction in health care costs and other measures of health care use. There was also a simultaneous improvement in HEDIS measures of quality care. These data suggest that disease management may result in savings for sponsored managed care organizations and that improvements in HEDIS measures are not necessarily associated with increased medical costs.

Diabetes Care 25:684–689, 2002

D iabetes is associated with significant health care costs. It has been estimated to affect 16 million Americans, with \$44 billion a year in direct medical and treatment costs. Although people with diabetes account for only 3.8% of the U.S. population, this disease accounts for 5.8% of all personal health care expenditures in the U.S. (1).

The cost of diabetes care for managed care organizations (MCOs) is also substantial. MCO enrollees with diabetes have higher rates of cardiovascular, eye, lower-extremity, and renal disease compared with those without diabetes (2–4). Several studies have conclusively demonstrated that complications from diabetes can be reduced by aggressive glycemic control (5–10). As a result, many MCOs have sponsored initiatives to improve glycemic control among their members in the belief that this will reduce the rate of diabetes complications and associated health care costs.

Improving health outcomes and lowering use and costs underlie the strategy of disease management. Disease management is defined as any multifaceted pro-

From the ¹Care Coordination Program, Geisinger Health Plan, Danville, Pennsylvania; and the ²Quality Improvement Program, Geisinger Health Plan, Danville, Pennsylvania.

Address correspondence and reprint requests to Jaan Sidorov, Care Coordination Program, Geisinger Health Plan, Hughes Office Building, Danville, PA 17822-3020. E-mail: jsidorov@geisinger.edu.

Received for publication 18 October 2001 and accepted in revised form 10 January 2002.

R.H. has been on advisory boards for and has received honoraria for speaking engagements from Pfizer, Eli Lilly, Aventis, Merck, Bristol-Myers Squibb, and GlaxoSmithKline Beecham. He has also received honoraria for speaking engagements from Lifescan and has been provided with grant/research support from Pfizer.

Abbreviations: GHP, Geisinger Health Plan; HEDIS, health employer data and information set; HMO, health maintenance organization; MCO, managed care organization; TPA, third-party administration.

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

gram devoted to the care of populations characterized by the presence of a chronic disease. Disease management programs are usually financed with a fixed percentage of the insurance premium. If complication rates are lowered, the lower use and associated savings can result in profit for the sponsoring organization. Characteristics of disease management programs typically include disease staging, promotion of clinical guidelines, patient education that promotes self-management, aggressive screening for complications, and early and appropriate specialty referral (11–17).

Little is known about the impact of disease management programs on health care costs, quality of care, and complication rates among patients with diabetes. Disease management programs for diabetes vary in scope and content, and a significant number are offered by independent companies under proprietary circumstances (17–19). It is also unclear whether disease management can result in short-term savings because the consequences of poor glycemic control occur over many years (20–24).

In this study, we describe the short-term medical cost savings associated with a health maintenance organization (HMO)-sponsored disease management program by comparing the claims of enrollees who fulfilled health employer data and information set (HEDIS) criteria and were in disease management with those not in disease management.

RESEARCH DESIGN AND METHODS

Setting

Geisinger Health Plan (GHP) is a federally qualified, not-for-profit group model HMO with 295,000 enrollees in 41 counties in northeastern and central Pennsylvania. It is part of the Geisinger System, which also supports a multispecialty group practice clinic consisting of 587 physicians located in 64 clinic sites as well as two closed-staff hospitals. GHP also independently contracts with a network of 4,192 providers and 57 hospitals. Several types of managed care insurance are offered by GHP, including commercial, Medicare risk, small business, group, individual, and third-party administration (TPA). Seventy-three percent of enrollees use one of a series of pharmacy benefit packages that can be purchased as a separate rider with a variety of patient co-pay options. Glucose monitors

and strips are considered durable medical equipment and are covered unless specifically excluded, as negotiated under a TPA arrangement. GHP is fully accredited by the National Committee on Quality Assurance. As part of the accreditation process, GHP conducts yearly measures of the quality of diabetes care using HEDIS criteria, which is a set of performance measures obtained using a proscribed methodology designed to enable purchasers to reliably compare the performance of different managed health care plans (25).

Description of the program

Overview

On 1 April 1997, GHP's disease management department began to recruit patients for diabetes disease management. At the time of this study, our department used a network of 51 primary care nurse educators and case managers. These registered nurses provide patient education and case management services in all physician clinics that contract with GHP for primary care services. Depending on member enrollment and geographic proximity, each nurse is responsible for 1–15 primary care sites. Each nurse is trained in diabetes patient education as well as tobacco cessation, congestive heart failure, hypertension, chronic obstructive pulmonary disease, and asthma. In fiscal year 2000, the total cost of this program, including capital, totaled just over \$4.2 million, with 4,262 continuously and currently enrolled patients who entered diabetes disease management. This consists of ~43% of all patients ever seen by the disease management nurses (26).

Patient education by the nurses at each primary care clinic is provided one on one or in group settings by appointment. Each nurse encounter is documented in the patient's medical record for physician review and co-signature. Nurses are allowed to use judgment in accommodating local physician preferences and practice styles. There is no charge rendered for the nurse education and no net financial gain or loss for the primary care site. Each nurse is also responsible for baseline and ongoing collection of data from the patient or from the medical record for later entry in database registries. Use of this approach to achieve outcomes in the areas of tobacco cessa-

tion, living wills, and diabetes care has been previously reported (27–29).

Description of diabetes disease management

A detailed description of the GHP diabetes disease management program has been described elsewhere (29). Briefly, this is a package of interventions, given over 1 year, consisting of promotion of diabetes clinical guidelines by the nurses in their day-to-day interactions with primary care physicians and patients, HMO-sponsored continuing medical education sessions for primary care providers, early and appropriate specialty clinic referral, and primary care site-based patient education and case management by the HMO nurses. Patients must voluntarily opt in to participate. To aid recruitment, nurses can arrange the one-time provision of a glucose meter and 100 glucose meter strips at no cost, using clinical criteria from the diabetes guidelines. Additional glucose meter strips are available for monthly co-payment, ranging from \$8 to \$15. Any patient with diabetes may self-refer or be referred by their physician. Depending on patient and physician preference, baseline HbA_{1c} measurement, and the presence of any diabetic complications, all patients are seen one to four times by the nurse from the date of referral. All participants are educated about the appropriate use of a glucose meter, the role of diet and exercise, the importance of HbA_{1c} testing, medication management, the management of hypoglycemia, and teaming closely with physicians in the use of staged diabetes management clinical guidelines (30) to achieve optimum blood glucose control.

Analysis of savings in diabetes disease management

GHP enrollees eligible for HEDIS analyses at the time of this study totaled 172,015 commercial HMO, 36,456 Medicare risk, and 47,004 patients with "point-of-service" insurance. Of 255,475 HMO enrollees, 6,799 (2.7%) fulfilled HEDIS criteria for the presence of diabetes. Of this latter group, 3,118 (45.8%) had been seen at least once by a GHP nurse since the program began in April 1997. HEDIS-specific data on all patients were obtained by a separate group of nurses (in the case of chart reviews) or data analysts (in the case of claims extracts) devoted to measuring quality improvement outside of

Table 1—Demographic, use, and HEDIS diabetes measure variables among 6,799 patients enrolled in disease management (program) versus those not in disease management (nonprogram)

Variable	Program	Nonprogram	Observed statistic	P
n (%)	3,118 (45.9)	3,681 (54.1)		
Demographic				
M/F (%)	1,589/1,529 (50.9/49.0)	1,947/1,734 (52.9/47.1)	$\chi^2 = 2.52$	0.1123
Mean years of age (CI)	69.5 (0.215)	70.9 (0.188)	$T = 3.54$	0.0001
Months enrollment duration (CI)	56.6 (0.724)	42.5 (0.724)	$T = 17.66$	0.0001
Pharmacy benefit (%)	1,615 (51.8)	1,733 (47.1)	$\chi^2 = 15.04$	0.0001
Insurance type				
Commercial/medicare (%)	771/2,347 (24.7/75.3)	592/3,089 (16.1/83.9)	$\chi^2 = 78.74$	0.0001
Use				
Mean member per month paid charges (CI)	\$394.62 (29.43)	\$502.48 (42.23)	$F = 18.61$	<0.0001*
Mean inpatient admissions per member per year (CI)	0.12 (0.02)	0.16 (0.02)	$F = 4.94$	0.026*
Mean inpatient days per member per year (CI)*	0.56 (0.10)	0.98 (0.25)	$F = 8.57$	0.003*
Mean emergency room visits per member per year (CI)*	0.49 (0.05)	0.56 (0.05)	$F = 2.32$	0.128*
Mean primary care office visits per member per year (CI)*	8.36 (0.22)	7.78 (0.20)	$F = 10.55$	0.001*
HEDIS				
HbA _{1c} testing (%)	3,019 (96.6)	3,083 (83.8)	$\chi^2 = 313.44$	0.0001
HbA _{1c} uncontrolled (%)†	35 (6.7)	79 (14.4)	$\chi^2 = 17.04$	0.0001
Lipid testing (%)‡	2,840 (91.1)	2,856 (77.6)	$\chi^2 = 226.24$	0.0001
Eye screening (%)‡	2,469 (79.1)	2,388 (64.9)	$\chi^2 = 167.83$	0.0001
Kidney screening (%)‡	2,135 (68.5)	1,446 (39.3)	$\chi^2 = 577.0$	0.0001

Data are n (%) or mean (CI), as indicated. *P value controlling for age, sex, presence of pharmacy, enrollment duration, and insurance type; †based on 526 program patients and 548 nonprogram patients; ‡based on 3,118 program patients and 3,681 nonprogram patients.

the disease management program. Personnel responsible for collecting or reporting HEDIS data were unaware of those patients that were in disease management at the time of their review.

All GHP members with commercial, including point-of-service, or Medicare risk insurance fulfilling HEDIS criteria for diabetes during the 2-year period from 1 July 1999 to 30 June 2001 had all enrollment data and submitted claims for health or medical care downloaded from the HMO claims database and entered into SAS version 8.0. The criteria used to identify members who fulfill HEDIS criteria are described elsewhere (25). Pharmacy claims were not included in this analysis. Unique member identification numbers were sorted into those who had seen an HMO disease management nurse at least once for diabetes education (program patients) and those not entered into disease management (nonprogram patients). Mean total claims paid per member per month, mean admissions per patient per year, mean number of inpatient days per patient per year, and mean number of emergency room and primary care office visits were compared in the two groups. We also compared HEDIS scores for HbA_{1c} testing, percent not in control, di-

abetic eye screening, and kidney disease screening in the two groups. Duration or specific type of diabetes is not included in any HEDIS measure, and this information is not included in this analysis. χ^2 tests were used to examine the significance of any observed differences in tests of proportion. Student's *t* tests were used to examine the statistical significance of any observed differences in tests of continuous data. Multiple linear regression and the resulting *F* statistic was used to control for age, sex, presence of pharmacy benefit, HMO enrollment duration, and insurance type to more precisely describe the significance of continuous data.

RESULTS— There were 6,799 continuously enrolled patients who fulfilled diabetes HEDIS criteria during the 2 years of this study. A total of 3,118 (45.9%) subjects had enrolled in disease management and were managed by 51 disease management nurses, as compared with 3,681 (54.1%) subjects who were not in disease management. The average number of visits with an HMO nurse was 3.63. A total of 419 (13.43%) patients visited a nurse one time, and 2,699 (86.57%) visited a nurse two or more times. Table 1 compares the male-to-female ratio, age,

HMO enrollment duration, presence of a pharmacy benefit plan, and insurance type (commercial versus Medicare risk) between the study subjects fulfilling HEDIS criteria who were in disease management (program) and those fulfilling HEDIS criteria who were not in disease management (nonprogram). Of the demographic variables, sex was not significantly different between the two groups ($P > 0.05$), but program patients were on average 1.4 years younger ($P < 0.05$), had longer enrollment duration in the HMO, were more likely to have a pharmacy benefit plan, and were more likely to have commercial insurance ($P < 0.05$ for all four measures).

During the 2-year period of study, program patients experienced \$394.62 per member per month in mean total paid claims, as compared with \$502.48 for those not in disease management ($P < 0.05$, Student's *t* test). This difference was accompanied by lower inpatient use among program patients, who experienced a mean of 0.12 admissions per patient per year and 0.56 inpatient days per patient per year, as compared with nonprogram patients, who had 0.16 admissions and 0.98 inpatient days per patient per year ($P < 0.05$ for both measures).

The mean number of emergency room visits was 0.49 per patient for program patients compared with 0.56 among nonprogram patients ($P < 0.05$). In contrast to emergency room use, program patients experienced a higher mean number of primary care office visits (8.4) per patient per year compared with nonprogram patients (7.8). When these data were compared while statistically controlling for age, sex, enrollment duration, presence of a pharmacy benefit, and insurance type, all measures of use, except for emergency room visits, remained statistically significant (Table 1). When enrollees in commercial and Medicare risk insurance lines were compared separately, statistically significant lower mean paid claims per member per month among the program patients, as compared with nonprogram patients, persisted (\$302.19 vs. \$527.96 and \$424.00 vs. \$500.37, respectively, $P < 0.05$ for all measures).

Program patients also experienced favorable HEDIS scores compared with nonprogram patients. HbA_{1c} testing as well as lipid, eye, and kidney screening were 96.6, 91.1, 79.1, and 68.5%, respectively, among program patients compared with 83.8, 77.6, 64.9, and 39.3%, respectively, among nonprogram patients. All observed differences were statistically significant ($P < 0.05$). A total of 1,074 patient charts (526 program and 548 nonprogram patients) were reviewed for determination of HbA_{1c} under control. Thirty-five (6.7%) program patients had HbA_{1c} >9.5% compared with 79 (14.4%) nonprogram patients (Table 1).

CONCLUSIONS— These retrospective data demonstrate that participants in a managed care–sponsored diabetes disease management program experienced lower overall paid insurance claims for health care compared with those not in disease management. This difference was not only statistically significant but substantial, amounting to \$104.86 per member per month or \$ 1,294.32 per year. For the 3,118 continuously enrolled patients included in this analysis, this amounts to a total of \$4,035,689.70 per year in fewer claims paid compared with nonprogram patients. Lower claims for program patients were present in both commercial and Medicare risk insurance. As noted above, the total budget, including capital for all disease management programs in this HMO, was ~\$4.2 million per year.

Because ~43% of all patients seen in disease management had diabetes, we believe the estimated allocated cost of ~\$1.81 million for diabetes disease management contrasts favorably with the \$4,035,689.70 in fewer claims for the patients included in this analysis. We found that much of the observed savings were accompanied by comparatively lower measures of inpatient use, with fewer admissions and fewer inpatient days. These findings persisted after we statistically controlled for factors that could alter health care use, such as age, sex, duration of enrollment in the HMO, presence of a pharmacy benefit, and type of insurance. Because all insurance claims for each year of the study were recorded among the HMO enrollees we examined, it is unlikely that the savings were underestimated (31).

Our findings also add to the weight of evidence linking diabetes disease management to health care use and glycemic control. We found that patients in disease management not only experienced lower charges but also had significantly higher measures in the key diabetes HEDIS measures. Although our data do not support the assertion that increased quality causes lower health care costs, we did find it is possible to achieve both at the same time. This association between cost and glycemic control has been previously described. Davies et al. (32) examined the effectiveness of nurse-based diabetes education and found less inpatient use was associated with better glycemic control. Menzin et al. (33) also linked insurance claims and mean HbA_{1c} levels among 2,394 patients with diabetes in the Fallon Clinic Health Plan. As in this study, the economic impact of blood glucose control was apparent within a relatively short period of time and was also manifested by less inpatient use. Gilmer et al. (34) and Wagner et al. (35) also found hospitalizations and overall health care costs in a managed care setting to be positively associated with elevated HbA_{1c} levels. Others outside of managed care have shown that in randomized clinical trials, achieving a lower HbA_{1c} is associated with fewer complications and lower health care costs (36,37).

These data also support the findings of other researchers who have shown that nurses can champion clinical guidelines and provide diabetes education to achieve significant improvements in blood glu-

cose control (38–45). This approach compares favorably with usual primary care, in which up to 40% of patients with diabetes do not have a measurement of their HbA_{1c} (46). Aubert et al. (47) found that in a randomized clinical trial, nurse managers can achieve significant improvements in blood glucose among primary care patients. As in this program, these nurses relied on staged diabetes management guidelines, which also have been shown to result in better glycemic control (48).

To our knowledge, this is the first report linking HEDIS and use. HEDIS theoretically enables purchasers to compare quality among competing MCOs. Purchasers also use other considerations when choosing an MCO, such as premium amount, network size, and financial stability. Despite widespread use of HEDIS, managed care has been criticized for failing to convince purchasers to rate quality of care over other factors in purchasing decisions (49). Our data suggest that patient education, clinical guidelines with provider teaming, and financial performance need not be mutually exclusive.

The growth of independent disease management companies, financed through a percentage of the insurance premium, is further evidence of a widespread belief that this strategy can achieve bottom-line savings. Reports of their success across a variety of managed care settings, in lowering use or improving outcome measures, also stress the effectiveness of clinical guidelines and team-based care, which promotes self-management (50–54).

Our findings may be biased. For example, greater willingness to cooperate with treatment recommendations, better health practices, or more interest in use of a glucose meter among patients who also agreed to opt in could explain the differences in use rather than disease management per se. In addition, because physicians had referred an unmeasured fraction of program patients, some of the differences in use could have been the result of differences in physician behavior outside of the disease management program. However, this program recruited just under one-half of all patients fulfilling HEDIS criteria for diabetes from the same network of primary care sites that cared for patients not in disease management. We also statistically controlled for known patient variables that could have accounted for the observed outcome differences. Because this disease management

program was available to all HMO members with diabetes, close to one-half of eligible patients used it. We statistically controlled for known confounding patient variables, and we believe the impact of other unmeasured patient factors could have caused nonrandom selection and fewer claims, reducing better outcomes in the disease management group. Regardless of potential patient selection bias, our simultaneous demonstration of improved clinical outcomes and lower use has important implications for health care organizations struggling to reconcile cost and quality.

Our data were also limited by restricting the claims analysis to overall paid charges. Although we found evidence of decreased inpatient use (manifested by fewer admissions and fewer inpatient days in program patients) and increased primary care office visits, we were unable to more fully characterize the savings. Although insurance claims are linked to diagnoses by ICD-9 code, we have anecdotally found that practice patterns and reimbursement issues significantly influence code selection, thus limiting our analysis. We were also unable to determine whether the HMO education nurses influenced health care use by redirecting their patients away from more costly services. We also caution that fewer insurance claims for health care do not necessarily mean lower health care costs, especially for patients who may experience significant out-of-pocket expenses. Our data are also limited by the lack of information concerning the use or cost of pharmaceuticals, which could also be responsible for changes in use. Our population resides in a largely rural setting, which may also limit the generalizability of our findings. Finally, this disease management program consisted of several interventions that in turn were adapted to accommodate local physician practice styles. Determining the source of short-term savings in disease management using methodologies that can prospectively and precisely define the relative contribution of each of the interventions typically used in multifaceted disease management programs is an area ripe for further research.

These issues can only be addressed through random selection and assignment of patients in a clinical trial using predefined clinical and financial criteria. Pending more research in this area, however, our data may demonstrate that disease management can simultaneously benefit participants and MCOs, with

lower health care use, significant savings, and higher health care quality.

References

1. American Diabetes Association: direct and indirect costs of diabetes [article online], 2002. Available from <http://www.diabetes.org/main/info/facts/impact/default2.jsp>. Accessed 7 February 2002.
2. Centers for Disease Control Diabetes in Managed Care Work Group: Diabetes mellitus in managed care: complications and resource utilization. *Am J Manag Care* 7:501-508, 2001
3. Selby JV, Ray GT, Zhang D, Colby CJ: Excess costs of medical care for patients with diabetes in a managed care population. *Diabetes Care* 20:1396-1402, 1997
4. Ramsey SD, Newton K, Blough D, McCulloch DK, Sandhu N, Wagner EH: Patient-level estimates of the cost of complications in diabetes in a managed-care population. *Pharmacoeconomics* 16:285-295, 1999
5. Ohkubo Y, Kishikawa H, Araki E, Miyata T, Isami S, Motoyoshi S, Kojima Y, Furuyoshi N, Shichiri M: 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* 28:103-117, 1995
6. Diabetes Control and Complications Trial Research Group: The effect of intensive treatment of diabetes on the development and progression of long-term complications in insulin-dependent diabetes mellitus. *N Engl J Med* 329:977-986, 1993
7. Krolewski A, Laffel L, Krolewski M, Quinn M, Warram J: Glycosylated hemoglobin and the risk of microalbuminuria in patients with insulin-dependent diabetes mellitus. *N Engl J Med* 332:1251-1255, 1995
8. Reichard P, Nilsson B-Y, Rosenqvist U: The effect of long-term intensified insulin treatment on the development of microvascular complications of diabetes mellitus. *N Engl J Med* 329:304-309, 1993
9. The Diabetes Control and Complications Trial Research Group: Effect of intensive diabetes management on macrovascular events and risk factors in the Diabetes Control and Complications Trial. *Am J Cardiol* 75:894-903, 1995
10. Stratton IM, Adler AI, Neil HA, Matthews DR, Manley SE, Cull CA, Hadden D, Turner RC, Holman RR: Association of glycemia with macrovascular and microvascular complications of type 2 diabetes. *BMJ* 321:405-412, 2000
11. Joshi MS, Bernard DB: Classic CQI integrated with comprehensive disease management as a model for performance improvement. *J Qual Improv* 25:383-395, 1999
12. Johnson N: Assessing and reporting outcomes of a disease management program. *Formulary* 34:455-460, 1999
13. Armstrong EP: Disease state management and its influence on health systems today. *Drug Benefit Trends* 8:18-20, 25, 29, 1996
14. Harris J: Disease management. New wine in new bottles? *Ann Int Med* 124:838-842, 1996
15. Pasternak DP, Harris JM: Does disease management work? *Physician Executive* 22:28-32, 1996
16. Ellrodt G, Cook DJ, Lee J, Cho M, Hunt D, Weingarten S: Evidence-based disease management. *JAMA* 278:1687-1692, 1997
17. Epstein RS, Sherwood LM: From outcomes research to disease management: a guide for the perplexed. *Ann Int Med* 124:832-837, 1996
18. Bodenheimer T: Disease management: promises and pitfalls. *N Engl J Med* 340:1202-1205, 1999
19. Greenlaugh T, Herxheimer A, Isaacs AJ, Beaman M, Morris J, Farrow S: Commercial partnerships in chronic disease management: proceeding with caution. *BMJ* 320:566-568, 2000
20. Eastman RC, Javitt JC, Herman WH, Dasbach EJ, Copley-Merriman C, Maier W, Dong F, Manninen D, Zrozek AS, Kotsanos J, Garfield SA, Harris M: Model of complications of NIDDM. II. Analysis of the health benefits and cost-effectiveness of treating NIDDM with the goal of normoglycemia. *Diabetes Care* 20:735-744, 1997
21. Macleod MK, Tooke JE: Direct and indirect costs of cardiovascular and cerebrovascular complications of type II diabetes. *Pharmacoeconomics* 8 (Suppl. 1):46-51, 1995
22. Guo JJ, Givson JT, Gropper DM, Oswald SL, Barker KN: Empirical investigation of direct cost-of-illness and health care utilization of Medicaid patients with diabetes mellitus. *Am J Man Care* 4:1433-1446, 1998
23. O'Brien JA, Shomphe LA, Davanagh PL, Raggio G, Caro JJ: Direct medical costs of complications resulting from type 2 diabetes in the U.S. *Diabetes Care* 21:1122-1128, 1998
24. Brown JB, Pedula KL, Bakst AW: The progressive cost of complications in type 2 diabetes mellitus. *Arch Intern Med* 159:1873-1880, 1999
25. NCQA: the health plan employer data and information set (HEDIS) [article online], 2002. Available from <http://www.diabetes.org/main/info/facts/impact/default2.jsp>. Accessed 7 February 2002.
26. Sidorov JE: The Continuous Health Improvement Program: research in a managed care setting. *HMO Practice* 11:97-

- 99, 1997
27. Sidorov JE, Christianson M, Girolami S, Wydra C: A successful primary care nurse led tobacco cessation program in a managed care setting. *Am J Managed Care* 3:207-214, 1997
 28. Sidorov JE: Successful promotion of the proxy for healthcare among outpatient enrollees of an HMO (Abstract). *J Gen Int Med* 11:87S, 1996
 29. Sidorov JE, Harris RE, Shull RD, Girolami S, Tomcavage J, Hughes R, Starkey R, Gabbay R: Disease management for diabetes mellitus: impact on hemoglobin A_{1c}. *Am J of Managed Care* 6:1217-1226, 2000
 30. Mazze RS, Etwiler DD, Strock E, Peterson K, McClave CR 2nd, Meszaros JF, Leigh C, Owens LW, Deeb LC, Peterson A, Kummer M: Staged diabetes management: toward an integrated model of diabetes care. *Diabetes Care* 17 (Suppl. 1): S56-S66, 1994
 31. Norlund A, Apelqvist J, Bitzen PO, Nyberg P, Schersten B: Cost of illness of adult diabetes mellitus underestimated if comorbidity is not considered. *J Intern Med* 250:57-65, 2001
 32. Davies M, Dixon S, Currie CJ, Davis RE, Peters JR: Evaluation of a hospital diabetes specialist nursing service: a randomized controlled trial. *Diabet Med* 18:301-307, 2001
 33. 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* 24:51-55, 2001
 34. Gilmer TP, O'Conner PJ, Manning WG, Rush WA: The cost to health plans of poor glycemic control. *Diabetes Care* 20:1847-1853, 1997
 35. Wagner EH, Sandhu N, Newton KM, McCulloch DK, Ramsey SD, Grothaus LC: Effect of improved glycemic control on health care costs and utilization. *JAMA* 285:182-189, 2001
 36. Clarke P, Gray A, Adler A, Stevens R, Raikou M, Cull C, Stratton I, Holman R, for the UK Prospective Diabetes Study Group: Cost-effectiveness analysis of intensive blood-glucose control with metformin in overweight patients with type II diabetes (UKPDS no. 51). *Diabetologia* 44: 298-304, 2001
 37. Gray A, Raikou M, McGuire A, Fenn P, Stevens R, Cull C, Stratton I, Adler A, Holman R, Turner R: Cost effectiveness of an intensive blood glucose control policy in patients with type 2 diabetes: economic analysis alongside randomized controlled trial. *BMJ* 320:1373-1378, 2000
 38. 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
 39. Piette JD, Weinberger M, McPhee SJ, Mah CA, Kraemer FB, Crapo LM: Do automated calls with nurse follow-up improve self-care and glycemic control among vulnerable patients with diabetes? *Am J Med* 108:20-27, 2000
 40. Peters AL, Davidson MB, Ossorio RC: Management of patients with diabetes by nurses with support of subspecialists. *HMO Pract* 9:8-13, 1995
 41. Lob SH, Kohatsu ND: Case management: a controlled evaluation of persons with diabetes. *Clin Perform Qual Health Care* 8:105-111, 2000
 42. Blonde L, Guthrie P, Parkes JL, Ginsberg BH: Diabetes disease state management by diabetes educators in managed care (Abstract). *Diabetes* 46 (Suppl. 1):A61, 1997
 43. de Sonnaville JJ, Bouma M, Colly LP, Deville W, Wijkel D, Heine RJ: Sustained good glycaemic control in NIDDM patients by implementation of structured care in general practice: 2-year follow-up study. *Diabetologia* 40:1334-1340, 1997
 44. Kinmonth AL, Woodcock A, Griffin S, Spiegel N, Campbell MJ: Randomized controlled trial of patient centred care of diabetes in general practice: impact on current well being and future disease risk. The Diabetes Care From Diagnosis Research Team. *BMJ* 317:1202-1208, 1998
 45. Ridgeway NA, Harvill DR, Harvill LM, Falin TM, Forester GM, Gose OD: Improved control of type 2 diabetes mellitus: a practical education/behavior modification program in a primary care clinic. *South Med J* 92:667-72, 1999
 46. Anderson D: Managed care meets the diabetes-management challenge. *Bus Health* 13 (Suppl. A):10-21, 1996
 47. Aubert RE, Herman WH, Waters J, Moore W, Sutton D, Peterson BL, Bailey CM, Koplan JP: Nurse case management to improve glycemic control in diabetic patients in a health maintenance organization: a randomized controlled trial. *Ann Intern Med* 129:605-612, 1998
 48. 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* 22:1672-1678, 1999
 49. Quicquel KE Jr: Diabetes in a managed care system. *Ann Intern Med* 124:160-163, 1996
 50. Diabetes pathway slashes length of stay by 26%. *Hosp Case Manag* 7:8, 13, 1999
 51. DTCA Land Diabetes Management Pact with BM. *Disease Management News*, 25 January 1996: p. 1, 5, 1996
 52. Grundel BL, White GL Jr, Eichold BH 2nd: Diabetes in the managed care setting: a prospective plan. *South Med J* 92: 459-464, 1999
 53. McCulloch D: Managing diabetes for improved health and economic outcomes. *Am J Manag Care* 6 (21 Suppl.):S1089-S1095, 2000
 54. Rubin RJ, Dietrich KA, Hawk AD: Clinical and economic impact of implementing a comprehensive diabetes management program in managed care. *J Clin Endocrinol Metab* 83:2635-2642, 1998