Title

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Journal

Annals of Internal Medicine, 145(2)

ISSN

1056-8751

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Publication Date

2006-07-18

DOI

10.7326/0003-4819-145-2-200607180-00008

Peer reviewed

The Association between Quality of Care and the Intensity of Diabetes Disease Management Programs

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Background: Although disease management programs are widely implemented, little is known about their effectiveness.

Objective: To determine whether disease management by physician groups is associated with diabetes care processes, control of intermediate outcomes, or the amount of medication used when intermediate outcomes are above target levels.

Design: Cross-sectional study.

Setting: Patients were randomly sampled from 63 physician groups nested in 7 health plans sponsored by Translating Research into Action for Diabetes (87%) and from 4 health plans with individual physician contracts (13%).

Patients: 8661 adults with diabetes who completed a survey (2000–2001) and had medical record data.

Measurements: Physician group and health plan directors described their organizations' use of physician reminders, performance feedback, and structured care management on a survey; their responses were used to determine measures of intensity of disease management. The current study measured 8 processes of care, including most recent hemoglobin A_{1c} level, systolic blood pressure, serum low-density lipoprotein cholesterol level, and several measures of medication use.

Results: Increased use of any of 3 disease management strategies was significantly associated with higher adjusted rates of retinal screening, nephropathy screening, foot examinations, and measurement of hemoglobin A_{1c} levels. Serum lipid level testing and influenza vaccine administration were associated with greater use of structured care management and performance feedback. Greater use of performance feedback correlated with an increased rate of foot examinations (difference, 5 percentage points [95% CI, 1 to 8 percentage points]), and greater use of physician reminders was associated with an increased rate of nephropathy screening (difference, 15 percentage points [CI, 6 to 23 percentage points]). No strategies were associated with intermediate outcome levels or level of medication management.

Limitations: Physician groups were not randomly sampled from population-based listings, and disease management strategies were not randomly allocated across groups.

Conclusions: Disease management strategies were associated with better processes of diabetes care but not with improved intermediate outcomes or level of medication management. A greater focus on direct measurement, feedback, and reporting of intermediate outcome levels or of level of medication management may enhance the effectiveness of these programs.

Ann Intern Med. 2006;145:107-116. www.annals.org

For author affiliations, see end of text.

*See Appendix 1 (available at www.annals.org) for a complete list of the TRIAD Study Group.

Persons with diabetes continue to receive suboptimal care (1–6). To improve quality, many health systems have implemented disease management programs for diabetes and other chronic conditions (7–9). These programs typically incorporate population-based strategies, such as disease registries, clinical guidelines, performance feedback, physician reminders, self-management support for patients, and targeted case management for high-risk patients (10).

Evidence for the effectiveness of disease management comes primarily from small efficacy trials (10–20). Such studies consistently found improved processes of diabetes care; however, improvements in outcomes (such as control of cardiovascular disease risk factors) were less consistent (12, 17, 18, 20–22). Furthermore, most studies evaluated only 1 or 2 strategies (instead of multicomponent programs) in selected clinical settings. It is unclear how well findings from these smaller studies apply to entire patient populations.

Many components of disease management focus on improving processes of care. Early performance measurement projects, such as the Health Plan Employer Data Information System (23) and the Diabetes Quality Improvement Program (5), emphasized the importance of such processes as annual retinal screening or hemoglobin A_{1c} determination. Particularly for health plans, process measures are more readily available than are outcomes data. However, if disease management is to improve patient outcomes, it must also improve intermediate outcomes, such as hemoglobin A_{1c} levels, systolic blood pressure, and serum low-density lipoprotein (LDL) cholesterol levels.

Translating Research into Action for Diabetes

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Context

Little is known about the effects of quality-of-care improvement programs on the process of care and outcomes of diabetes.

Contribution

The study involved 8661 patients with diabetes, 63 provider groups, and 3 disease management strategies (provider feedback, reminders, and structured care). The quality measures included 8 processes of care, 3 intermediate diabetes outcomes, and medication management of these outcomes. More intense disease management strategies predicted higher measures of many processes of care but only 1 intermediate outcome and 1 medication management outcome.

Implications

The disease management strategies improved processes of care but not outcomes. Experts in quality improvement may need to refocus their efforts.

—The Editors

(TRIAD) (24) is a multicenter study of diabetes care in managed care. The TRIAD study's central hypothesis is that health care systems features can affect quality of care. Here, we examine how 3 disease management strategies vary in intensity across physician groups and whether physician groups with more intensive disease management have higher quality of diabetes care. We assess quality by processes of care, by levels of intermediate outcomes, and by current clinical management of these outcomes.

Methods

Overview of the TRIAD Study and Sample

The TRIAD study's sampling frame, methods, key hypotheses, and power calculations are detailed elsewhere (24). The study comprised 6 collaborating translational research centers that were partnered with 10 managed care health plans in 7 states. Of the 10 plans, 7 contracted with 1 to 26 physician groups (total, 68 groups), whereas 4 plans directly contracted with individual physicians.

A standard algorithm was applied to automated pharmacy, laboratory utilization, and inpatient and outpatient diagnostic data (25) to identify all community-dwelling patients with diabetes who were 18 years of age and older and who had been continuously enrolled in the TRIAD health plan for at least 18 months. The study cohort was randomly sampled from this population.

Sampled patients were recruited between July 2000 and October 2001 by using computer-assisted telephone interviews or written surveys that were conducted in English or Spanish. Eligibility was confirmed if patients verified that they had had diabetes for at least 12 months and had received most of their diabetes care through the TRIAD health plan. Permission was sought from all respondents to request copies of their outpatient medical records for the previous 18 months.

All health plan and physician group directors received mailed surveys (**Appendix Figure**, available at www.annals.org) during the same interval. Face-to-face or telephone interviews were used to complete and clarify responses. Each director was offered $100 for completing the survey.

The TRIAD study was reviewed and approved by the institutional review boards of each research center and by the Centers for Disease Control and Prevention (CDC). Informed consent was obtained from all survey respondents.

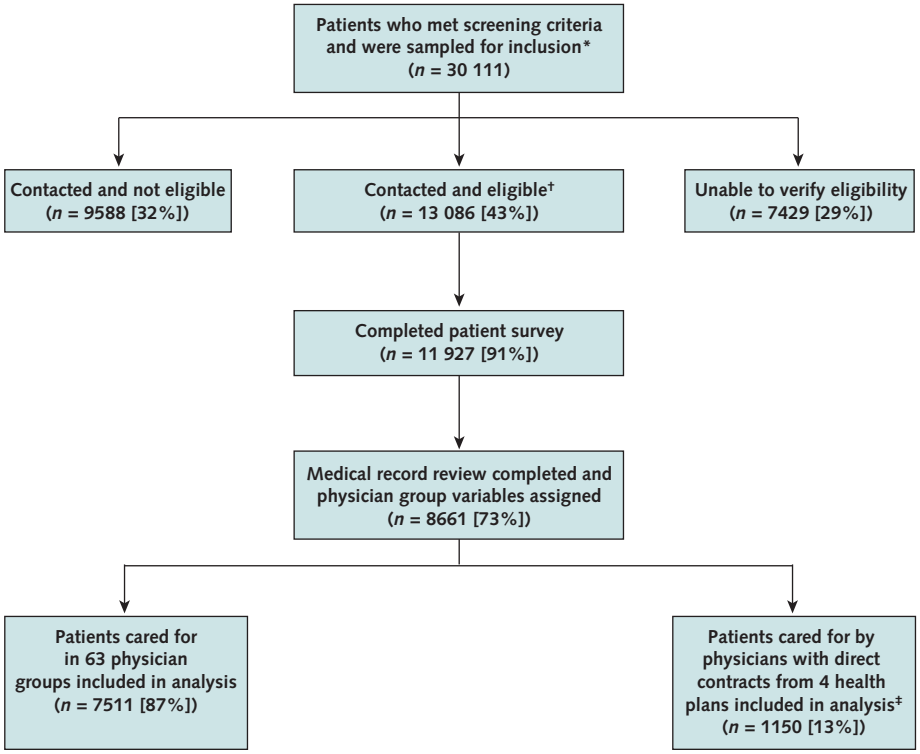
Data Sources

Patient surveys included questions on health status, diabetes duration, current diabetes treatment, and demographic characteristics. Of 13 086 contacted and eligible persons, 11 927 (91%) completed the survey (56.6% by computer-assisted telephone interview and 43.4% by written survey) (**Figure**). We were unable to contact many individuals. Using a practice that is endorsed by the Council of American Survey Research Organizations (26), we assumed that persons whom we could not contact or for whom we could not confirm eligibility had the same eligibility rate as those contacted. Under that assumption, the response rate was 69%.

Of 11 927 patients who completed a survey, 8661 (73%) consented to medical record review and subsequently had charts available for review. Centrally trained reviewers used standardized data collection software to abstract process measures, most recent levels of hemoglobin A_{1c}, upper limits of normal for hemoglobin A_{1c} measurements that were recorded, serum LDL cholesterol levels, systolic blood pressure, current medications, and comorbid conditions. Interrater reliability (κ) for the main quality measures ranged from 0.86 to 0.94.

All 10 health plan directors and 52 of 68 physician group directors completed surveys. Surveys assessed organizational age, size, structure, profit status, insurance products, contracting arrangements, history of involvement with managed care, and detailed information on the organization's use of diabetes disease management strategies. Of the physician groups that did not respond (443 participants), 11 existed solely for the purpose of contracting with plans and had no diabetes disease management. These physician groups were assumed to have no care management strategies and were included in the analyses, as were patient groups (1150 participants) from the 4 health plans that contracted directly with physicians. The remaining 5 groups (159 participants) did not respond and were excluded from analyses (**Figure**). Consequently, the resulting sample included a total of 8661 survey respondents with charts available for review and data from 63 physician groups and 4 additional health plans (**Figure**). Mean duration of diabetes, body mass index, and health status did not

Figure. **Description of sampling and response rate.**



*Patients receiving care in one of the Translating Research into Action for Diabetes (TRIAD) study health plans and whose diabetes diagnosis was based on the following criteria: a diagnostic code for diabetes (for example, 2 or more outpatient visits with International Classification of Diseases, Ninth Revision, code 250.*xx*) or 1 or more inpatient stays with an associated diabetes code; results of laboratory studies suggestive of diabetes (for example, 2 or more hemoglobin A_{1c} tests or diagnostic levels of hemoglobin A_{1c} or fasting blood glucose); or a prescription for medications for diabetes (for example, insulin or an oral antidiabetic agent). †At the time of the survey, patients who met the initial criteria were included only if they verified that they had diabetes and received most of their diabetes care through the participating TRIAD health plan. ‡Participants cared for under direct contracting agreements with health plans rather than in physician groups were assigned a value of 0 for each care management strategy at the physician group level.

meaningfully differ between persons whose medical records and physician group variables were available to the study team and those whose records were unavailable.

Predictors, End Points, and Covariates

The primary predictors were 3 measures of the intensity of disease management strategies: physician reminders, performance feedback, and structured care. These were calculated for physician groups and health plans from multiple survey items. A detailed description of the methods used to calculate composite intensity scores is provided in Appendix 2 (available at www.annals.org). Selected item-level responses for physician groups in the most intense versus least intense tercile of each strategy are displayed in **Table 1**.

The physician reminders intensity score was derived from 2 questions, which detailed the types and content of the reminders physicians received. Groups whose use of reminders represented the upper tercile of intensity were found to have reminded physicians about 4 care processes on average. Most groups in the upper tercile delivered reminders electronically at the point of care.

Performance feedback intensity was obtained by tallying responses to a checklist of possible diabetes process and outcome feedback items. A total of 86% and 82% of groups in the upper tercile included levels of hemoglobin A_{1c} and serum LDL cholesterol, respectively, in feedback to physicians (**Table 1**). Physician feedback focused on many of the same elements of care as reminders.

The use of formal case management, diabetes guidelines, patient reminders, and diabetes education correlated highly in physician groups (Pearson correlation coefficients ranged from 0.63 to 0.88); therefore, we could not look at these approaches independently. Consequently, we combined the 4 approaches into a single composite score for "structured diabetes care management." Use of formal case management was assessed by the proportion of patients with diabetes who were enrolled, the number of case managers per 10 000 patients, the extent to which the program targeted high-risk patients, and a checklist of case management activities. The clinical guidelines were scored to reflect the extent of implementation. The highest score was assigned to physician groups that incorporated guidelines

Table 1. **Selected Item-Level Responses for Provider Groups for Each Disease Management Strategy***

Composite	Component Indicators	Items from Survey	Raw Physician Group Average Positive Responses	
			Lower Tercile	Upper Tercile
Physician feedback	Number of items fed back	Rates of processes fed back		
		Hemoglobin A_{1c} testing	0%	100%
		Dilated eye examination	0%	100%
		Serum LDL cholesterol testing	0%	100%
		Nephropathy screening	0%	100%
		Hospital admissions	0%	86%
		ACE inhibitor use	0%	77%
		Administration of influenza vaccine	0%	77%
		Visits to podiatrist	0%	59%
		Visits to nutritionist/diabetes educator	0%	41%
		Outcome level by provider		
		Serum LDL cholesterol level	0%	86%
		Hemoglobin A_{1c} level	0%	82%
Physician reminders	Type of reminder	Preprinted guidelines	0%	91%
		Customized alerts on the medical records on the day of a visit	0%	59%
		Mailed list of patients with needed services	0%	52%
		Flow sheets for individual patients	0%	41%
	Number of reminders	Hemoglobin A_{1c} testing due	0%	59%
		Serum lipid screening due	0%	59%
		Dilated eye examination due	0%	59%
		Foot examination due	0%	59%
		Nephropathy screening due	0%	45%
		Reminder to consider ACE inhibitor therapy	0%	18%
		Reminder to consider serum lipid-lowering treatment	0%	18%
Diabetes care management	Use of case management	Type of patient assigned		
		Primary care physician referrals	0%	73%
		Recently discharged	0%	68%
		High risk for microvascular and macrovascular complications	0%	68%
		Patient preference	0%	27%
		Median case managers per 10 000 patients	0	4.5/10 000
	Use of disease management program	Is there a diabetes disease management program?	0%	100%
		When (mean year) implemented?	NA	1998
		Percentage enrolled	0%	91.8%
	Use of guidelines	Written form to physicians	0%	100%
		Computerized form to physicians	0%	100%
		Incorporated into physician reminders	0%	73%
		Presented in educational talks	0%	73%
	Use of patient reminders	Content		
		Hemoglobin A_{1c} testing due	0%	100%
		Serum lipid screening due	0%	100%
		Nephropathy screening due	0%	95%
		Dilated eye examination due	0%	82%
		Influenza vaccine due	0%	73%
		Foot examination due	0%	32%
		Type		
		Letter from patient's physician	0%	82%
		Telephone calls to patients	0%	55%
		Letter addressed to specific patients	0%	50%
	Use of diabetes education	Do you have diabetes educational classes?	0%	100%

* ACE = angiotensin-converting enzyme; LDL = low-density lipoprotein; NA = not applicable.

into automated physician or patient reminders. Patient reminder intensity incorporated the number, type, and frequency of reminders sent. On average, physician groups in the upper tercile had diabetes education as a covered benefit, whereas those in the lowest tercile generally did not have these programs.

Because of the differing numbers of questions and wide range of possible values within each intensity score, each question was *z*-transformed to a mean of 0.0 and standard deviation near or equal to 1.0 to facilitate comparison. Scores for each of the care management composites were computed as the mean of its *z*-transformed re-

sponses. A combined measure of disease management intensity was constructed for each plan and group by adding the 3 composite scores together. The distribution of *z*-transformed composite scores for the 67 groups is shown in **Appendix Table 1** (available at www.annals.org).

Study end points included the following 8 processes of care: levels of hemoglobin A_{1c}, serum lipids, and urine albumin; dilated retinal and foot examinations; recommendations for aspirin therapy and influenza vaccine; and counseling for smokers to encourage them to quit ($n = 1264$). The prevalence of the first 3 indicators was obtained exclusively from chart review; we used evidence from either the medical record or the patient survey to determine which of the remaining 5 measures had been performed. Each quality measure was the percentage of patients who received the process during the 12 months preceding the patient survey.

The second set of end points included the most recently recorded hemoglobin A_{1c}, serum LDL cholesterol, and systolic blood pressure values in the previous 12 months. These intermediate outcomes were analyzed as continuous and binary variables (hemoglobin A_{1c} level <8.0%, systolic blood pressure <140 mm Hg, and serum LDL cholesterol level <3.35 mmol/L [<130 mg/dL]).

We defined a third set of end points to reflect medical management of the 3 intermediate outcomes (**Table 2**). For each intermediate outcome, physician groups were assessed by the proportion of their patients with the condition who were at or below target levels or above target levels and currently receiving more medications (reflecting greater effort to manage the outcome) (27). Number of medications was dichotomized as use of 2 or more oral agents or insulin for diabetes; 1 or more lipid-lowering agents for hypercholesterolemia; and 2 or more antihypertensive agents for hypertension.

We used the patient survey to obtain the following model covariates: age, sex, ethnicity, education, income, health status from the Short Form-12 mental and physical component scores (28), duration of diabetes, and a 4-level treatment variable (diet-controlled, oral agents alone, oral agents and insulin, or insulin alone). The following 2 additional covariates, which described comorbid conditions and current therapies, were obtained from the medical record: the Charlson index (29, 30) and an additional measure of cardiovascular comorbidity that indicated presence of previous myocardial infarction, stroke, or coronary or carotid artery revascularization. All models were adjusted for intensity of care management and clustering at the health plan level.

Statistical Analysis

Both multiple imputation and modeling were performed with SAS statistical software, version 9.1.3 (SAS Institute Inc., Cary, North Carolina). Initial analyses examined distributions for predictors, outcomes, and covariates across physician groups. Fewer than 1% of patients had missing data for any key process-of-care variables. Hemoglobin A_{1c}, serum LDL cholesterol, and systolic blood pressure values were unavailable for 9%, 24%, and 5% of patients, respectively; these patients were excluded only from analyses of the missing end point. Short Form-12 scores and income were missing for approximately 11% of participants; values for all other covariates were missing in fewer than 5% of participants. Missing values for covariates (but not predictors or end points) were imputed 5 times. Each covariate was predicted as a function of all other covariates by using a Markov chain Monte Carlo multiple imputation algorithm (SAS PROC MI and PROC MIANALYZE functions).

Separate models assessed associations between each of the 3 disease management intensity scores and the combined intensity score with each process indicator, intermediate outcome level, and medication use variable. Because of the clustering of participants within physician groups and plans, hierarchical mixed-effects models were used to account for intraplan and physician group correlation. We used the SAS GLIMMIX procedure with penalized quasi-likelihood estimation for dichotomous outcomes and the

Table 2. **Clinical Management Measures for Hemoglobin A_{1c}, Systolic Blood Pressure, and Serum Low-Density Lipoprotein Cholesterol***

Measurement	Eligible Patients (Denominator)	Patients Receiving More Management Processes (Numerator)
Hemoglobin A_{1c} level	All patients	All patients with hemoglobin A_{1c} level <8% plus all others who receive therapy with insulin or ≥2 oral agents
Systolic blood pressure	All patients with a chart diagnosis of hypertension plus all others with systolic blood pressure ≥140 mm Hg	All patients with systolic blood pressure <140 mm Hg plus all others who are receiving therapy with ≥2 antihypertensive agents from distinct medication classes
Serum LDL cholesterol level	All patients with a chart diagnosis of hypercholesterolemia plus all others with serum LDL cholesterol level ≥3.35 mmol/L (≥130 mg/dL)	All patients with serum LDL cholesterol level <3.35 mmol/L (<130 mg/dL) plus all others who are receiving at least 1 lipid-lowering agent

* LDL = low-density lipoprotein.

Table 3. **Distributions of Patient Demographic Characteristics and Clinical Predictors across Physician Groups***

Characteristic	Value (n = 8661)	Interquartile Range by Physician Group (n = 67)
Mean patients per group, *n*	129	29–144
Mean age (SD), *y*†	60.7 (12.9)	55.7–66.9
Women, %	53.6	44.8–52.2
Ethnicity, %‡		
African-American	10.0	1–13
Asian/Pacific Islander	14.6	0–15
Hispanic	15.7	5–29
White	44.1	21–68
Other	8.7	3–10
Current smokers, %§	18.4	13.0–18.4
Mean Charlson index score (SD)‖	2.3 (1.6)	1.8–2.4
History of cardiovascular disease, %	25.7	17.3–31.7
Functional status¶		
SF-12 physical component score	43.2 (7.1)	42.4–44.4
SF-12 mental component score	44.9 (6.6)	44.4–45.7
Mean duration of diabetes (SD), *y***	12.0 (10.3)	11.1–13.2

* SF-12 = Short Form-12.
† Data not available for all patients (n = 8659).
‡ Data not available for all patients (n = 8163).
§ Data not available for all patients (n = 8550).
‖ Data not available for all patients (n = 8631).
¶ Data not available for all patients (n = 7858).
** Data not available for all patients (n = 8178).

SAS PROC MIXED procedure with restricted maximum likelihood estimates for continuous outcomes.

Our results are presented as model-based predicted probabilities of receiving each process of care in physician groups in the highest versus lowest tercile of intensity for each of the 3 disease management strategies. We used terciles of the distribution of disease management intensity to estimate interpretable differences in performance across the intensity distribution. In models predicting intermediate outcome levels and proportion of patients with controlled disease or receiving more medications, we did not adjust for diabetes treatment and health status because these 2 variables could mediate associations of disease management intensity with these outcomes.

We serially removed each of the health plans from the models, and we removed 1150 participants who did not receive care from physician groups to examine whether observed differences in processes of care were unduly affected by data from a single plan or from assigning a value of 0 to management indicators for physician group care, respectively. In separate sensitivity analyses, we examined whether our findings would be altered if we controlled for all 3 care strategies simultaneously or if we used cut-points for intermediate outcome control that were more stringent (hemoglobin A_{1c} level <7.0%; serum LDL cholesterol level <2.60 mmol/L [<100 mg/dL], and systolic blood pressure <130 mm Hg) or less stringent (hemoglobin A_{1c} level, 9.5%; serum LDL cholesterol level, 4.15 mmol/L [160 mg/dL]; and systolic blood pressure, 160 mm Hg). We also adjusted all hemoglobin A_{1c} analyses by the upper limit of normal for the assay used. None of these sensitivity analyses substantially changed the results (data not shown).

Role of the Funding Sources

The study was funded by the CDC and the National Institute of Diabetes and Digestive and Kidney Diseases. The study was designed and governed by a 7-member steering committee; the CDC has 1 representative on this committee. Analysts from the CDC provided us with statistical assistance, reviewed the manuscript, and provided feedback to us.

RESULTS

Analytical Sample

Sample characteristics across physician groups are presented in **Table 3**. Nearly every characteristic varied greatly across physician groups, particularly age, sex, ethnicity, and prevalence of cardiovascular disease. Intensity of disease management strategies also varied substantially across physician groups (**Table 1**).

Rates for diabetes process of care were high but varied across physician groups (**Table 4**). Median levels of the 3 intermediate outcomes indicated that more than 50% of patients were above American Diabetes Association guideline target levels for each intermediate outcome (31).

Association of Disease Management Strategies with Processes of Care

As measured by the 8 process indicators, intensity of disease management was strongly associated with quality (**Table 5**). Of 24 adjusted associations (3 disease management strategies by 8 processes of care), 17 associations significantly favored physician groups with increased disease management intensity. Adjusted differences in predicted probabilities between upper and lower terciles ranged from

5% to 15%. Greater intensity of structured care management was associated with significantly higher levels for 6 of 8 processes, with differences ranging from 7% to 11%. More intense physician performance feedback was also associated with higher rates for 6 of 8 process indicators, with significant differences of 5% to 10%. Increased intensity of physician reminders was associated with higher rates for 5 of 8 process measures, with differences ranging from 8% to 15%. The combined intensity measure was also significantly related to 6 of the 8 processes of care. No strategy was significantly associated with rates of providing advice to stop smoking (among smokers).

Association of Disease Management Strategies with Intermediate Outcomes

Greater intensity of structured care management was associated with adjusted systolic blood pressure levels that were 3 mm Hg (95% CI, 1 to 5 mm Hg) higher than those for lower intensity groups. The only other significant association was between greater intensity of physician reminders and slightly lower levels of serum LDL cholesterol (0.05 mmol/L [2 mg/dL]). Otherwise, disease management intensity and levels of the 3 intermediate outcomes were not associated (**Table 5**). Models predicting dichotomized outcomes (that is, below target levels) confirmed the lack of association of the 3 strategies or the combined measure with intermediate outcome control (data not shown).

Association of Disease Management Strategies with Medication Management of Intermediate Outcomes

For the end points of medication management, only 1 of the 12 associations showed a significant difference in the expected direction. Greater use of physician reminders was associated with a 7% (CI, 1% to 13%) increase in number of patients who had serum LDL cholesterol levels at target or who were using a cholesterol-lowering medication. Paradoxically, the only other significant finding suggested that persons in physician groups with the most intense, structured diabetes care management were 4% less likely to have a well-controlled hemoglobin A_{1c} level or to be receiving 2 or more medications or insulin (**Table 5**; **Appendix Table 2**, available at www.annals.org).

Discussion

Although disease management is widely implemented in managed care, its effectiveness has not been carefully examined. A lack of valid comparison groups and competing secular influences make it difficult to evaluate programs within single organizations. The TRIAD study makes it possible to estimate the impact of disease management by collecting detailed, standardized data across multiple physician groups that implement these strategies differently. In addition, the TRIAD health plans' standardized information allows us to control for health plan actions while we

Table 4. **Distribution of Quality Indicators, Mean Intermediate Outcome Levels, and Clinical Management Variables across Physician Groups***

Variable	Value (n = 8661)	Interquartile Range by Physician Group (n = 67)
Quality indicators performed in previous 12 months, %		
Dilated retinal examination	77.6	72.0–84.3
Nephropathy screening	78.6	69.7–84.8
Foot examination	83.7	76.0–86.8
Hemoglobin A_{1c}	84.8	79.3–91.0
Serum lipid panel	68.7	64.0–78.4
Recommendation for influenza vaccine†	65.4	56.8–71.3
Recommendation to take aspirin	53.8	44.8–57.9
Recommendation to quit smoking‡	89.7	81.8–100.0
Median intermediate outcomes (SD)		
Systolic blood pressure, *mm Hg*§	134 (18.9)	132.8–140.4
Serum LDL cholesterol level‖		
mmol/L	2.85 (0.90)	2.80–3.05
mg/dL	110 (34.1)	107.9–117.0
Hemoglobin A_{1c} level, %¶	7.6 (1.9)	7.6–8.2
Patients at target levels or receiving more therapy, %		
Systolic blood pressure**	75.7	66.1–81.8
Serum LDL cholesterol††	79.8	71.4–87.5
Hemoglobin A_{1c}¶	89.5	88.1–95.4

* LDL = low-density lipoprotein.
† Data not available for all patients (n = 8577).
‡ Data includes only patients who were current smokers (n = 1264).
§ Data not available for all patients (n = 8261).
‖ Data not available for all patients (n = 6465).
¶ Data not available for all patients (n = 7948).
** Data not available for all patients (n = 6567).
†† Data not available for all patients (n = 4563).

Table 5. **Adjusted Association of Physician Group Disease Management with Quality Indicators, Intermediate Outcome Levels, and Medical Management of Intermediate Outcomes***

Dependent Variables	Structured Care Management		Performance Feedback		Physician Reminders		Combined Score	
	Range, Third vs. First Tercile	Difference (95% CI)†	Range, Third vs. First Tercile	Difference (95% CI)†	Range, Third vs. First Tercile	Difference (95% CI)†	Range, Third vs. First Tercile	Difference (95% CI)†
Quality indicators, %								
Dilated retinal examination	81 to 73	**8 (2 to 14)**	82 to 76	**6 (2 to 10)**	83 to 73	**10 (6 to 15)**	83 to 74	**9 (4 to 14)**
Nephropathy screening	82 to 71	**11 (1 to 21)**	84 to 74	**10 (5 to 16)**	83 to 68	**15 (6 to 23)**	84 to 69	**15 (6 to 24)**
Foot examination	87 to 80	**7 (0 to 13)**	88 to 83	**5 (1 to 8)**	88 to 80	**8 (2 to 14)**	88 to 80	**8 (1 to 15)**
Hemoglobin A_{1c} test	88 to 79	**9 (4 to 15)**	90 to 82	**8 (5 to 12)**	88 to 79	**8 (4 to 13)**	89 to 78	**11 (5 to 17)**
Lipid panel tested	75 to 65	**10 (3 to 17)**	75 to 68	**7 (3 to 12)**	70 to 65	5 (−3 to 12)	76 to 67	**8 (2 to 15)**
Influenza vaccine advised	69 to 60	**9 (1 to 16)**	70 to 64	**6 (1 to 11)**	67 to 62	5 (−1 to 11)	67 to 63	4 (−4 to 11)
Aspirin therapy advised	50 to 50	0 (−7 to 8)	55 to 52	3 (−2 to 8)	56 to 48	**8 (2 to 13)**	56 to 47	**9 (2 to 16)**
Smoking cessation advised‡	92 to 90	2 (−4 to 7)	92 to 89	3 (−1 to 7)	91 to 88	3 (−2 to 7)	92 to 90	2 (−3 to 7)
Mean intermediate outcomes								
Hemoglobin A_{1c} level, *%*	8.0 to 7.9	0.1 (−0.3 to 0.4)	8.0 to 8.0	0.0 (−0.3 to 0.3)	8.0 to 8.0	0.0 (−0.3 to 0.3)	8.0 to 7.9	0.1 (−0.2 to 0.4)
Systolic blood pressure, *mm Hg*	138 to 135	**3 (1 to 5)**	136 to 136	0 (−2 to 2)	137 to 136	1 (−1 to 3)	138 to 136	**2 (0 to 4)**
Serum LDL cholesterol level								
mmol/L§	2.95 to 2.90	0.05 (−0.10 to 0.20)	3.00 to 2.90	0.10 (0 to 0.15)	2.90 to 3.00	**−0.10 (−0.10 to 0)**	2.95 to 2.95	0 (−0.10 to 0.10)
mg/dL	114 to 113	1 (−4 to 7)	115 to 113	2 (0 to 5)	113 to 115	**−2 (−3 to 0)**	114 to 114	0 (−4 to 4)
Patients at target levels or receiving more therapy, %‖								
Hemoglobin A_{1c}	90 to 94	**−4 (−8 to 0)**	93 to 93	0 (−1 to 1)	92 to 94	−2 (−4 to 0)	91 to 94	−3 (−7 to 0)
Systolic blood pressure	74 to 76	−2 (−10 to 5)	78 to 77	1 (−3 to 6)	76 to 77	1 (−4 to 7)	77 to 77	0 (−7 to 7)
Serum LDL cholesterol	84 to 81	3 (−4 to 11)	80 to 82	−2 (−7 to 3)	84 to 77	**7 (1 to 13)**	84 to 80	4 (0 to 11)

* Predicted range in each dependent variable for third versus first terciles of disease management intensity score. Separate hierarchical models performed for each disease management strategy and each dependent variable. For quality indicators, models are adjusted for patient age, sex, ethnicity, education, income, current diabetes treatment, duration of diabetes, Charlson index score, history of cardiovascular disease, physical component score of the Short Form-12, and intensity of health plan activity for same predictor. For intermediate outcome levels and medication use models, we omitted current treatment and the Short Form-12 physical component score as adjusters. Values shown in boldface are statistically significant. LDL = low-density lipoprotein.

† Difference in adjusted predicted values at third versus first tercile of the disease management intensity score.

‡ Model includes only the 1386 persons who were current smokers.

§ Lower/upper confidence limit of zero is a negative value that was rounded to zero.

‖ Medication use models for systolic blood pressure and serum LDL cholesterol level were restricted to 6520 and 4534 persons with diagnoses of hypertension and hyperlipidemia, respectively.

examine the influence of care management at the level of physician group.

Our findings indicate strong associations between the intensity of the 3 disease management strategies and better care processes. These were noted despite relatively high process scores among all physician groups (32). The magnitude of observed differences was moderate (generally ranging from 5% to 15%) but similar to differences achieved in efficacy trials of individual disease management interventions (12, 16). However, none of these disease management programs seemed to affect intermediate outcomes in a clinically meaningful way, and they were not associated with apparent differences in the amount of medications used to control these outcomes.

Our findings are consistent with previous reports. Keating and colleagues (33) studied diabetic patients in 1 market by using a summary quality score that included 4 processes and 2 measures of intermediate outcome control. Across 135 physician practices, they found that practice accounted for only a small proportion of variation in quality. Nonsignificant trends toward higher quality were found for practices that received diabetes performance report cards and those that routinely enrolled patients in disease management programs. Fleming and colleagues (34) found that practices that used multiple care management approaches were often in the upper quartile of the distribution in a similar quality composite score. In both of these reports, the quality scores were dominated by process measures, and the influence of diabetes care management on processes versus control of intermediate outcomes cannot be separated. The latter report also indicated that the relative influence of distinct care management practices, such as the use of reminders versus performance feedback at the health plan level, cannot be directly compared (34).

In our analysis, we must carefully consider the absence of positive associations between disease management and intermediate outcome levels or responsive adjustments to treatment regimens. Accreditation organizations gave early emphasis to simple process-of-care measures that were easy to assess with administrative data (for example, whether a hemoglobin A_{1c} test was done). Such approaches ignored intermediate outcome levels and their clinical treatments

(for example, whether there was management change in response to a high hemoglobin A_{1c} level). Disease management programs developed in response to accreditation undoubtedly focused more heavily on improving processes than outcomes of care. Our findings support the need for refinements in disease management that shift the focus toward direct measurement and feedback of intermediate outcomes and toward measurement of clinical processes of care that are more directly associated with improved outcomes (35, 36).

Improving intermediate outcomes is more challenging than altering simple care processes. Process improvement can be more readily applied to entire populations with diabetes; however, intermediate outcome control requires identification of patients with elevated levels, targeted interventions, and support of self-management. In addition, control of intermediate outcomes requires the active participation of primary care physicians who may yet lack sufficient knowledge, decision support, or time to appropriately support patients in achieving control (37).

Health plans also apply disease management strategies. Because there were only 10 TRIAD health plans, we cannot say whether use of these strategies at the health plan level would be associated with the same pattern of findings reported here at the physician group level.

Several additional limitations of this study deserve mention. Because these cross-sectional analyses were conducted after generally 3 or fewer years of disease management, it may be too early to detect effects on intermediate outcome levels. Our analytical sample included only 63 physician groups that were not randomly selected from a larger, population-based listing. Furthermore, disease management strategies were not randomly allocated across groups. A larger physician group sample could have increased sensitivity to modest associations by increasing the statistical power as well as increasing the variability in disease management intensity. We used "more medication" as a surrogate for more aggressive care, but our cross-sectional analyses could not be used to determine whether providers changed therapy in response to suboptimal control of an intermediate outcome. Because some patients did not provide consent, medical records could not be obtained for approximately 30% of the entire TRIAD sample. However, survey data indicated that patients with missing medical records were quite similar to the other participants in terms of demographic characteristics, duration of diabetes, and self-reported health status.

The TRIAD study suggests that the disease management programs implemented in these physician groups were associated with higher levels of care processes, but they did not seem to influence the intermediate outcomes that affect risk for complications or the medical management of these outcomes. As disease management programs give greater attention to improving intermediate outcomes and as process measures become more clinically relevant, these programs may be more likely to meet their long-term goal of improved health.

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Disclaimer: The contents of this paper are solely the responsibility of the authors and do not necessarily represent the official views of the Centers for Disease Control and Prevention and the National Institute of Diabetes and Digestive and Kidney Diseases.

Acknowledgment: The authors acknowledge the participation of their health plan partners.

Grant Support: This study was jointly funded by Program Announcement no. 04005 from the Centers for Disease Control and Prevention (Division of Diabetes Translation) and the National Institute of Diabetes and Digestive and Kidney Diseases. Dr. Kerr's role was supported by the Department of Veterans Affairs Health Services Research and Development Service.

Potential Financial Conflicts of Interest: None disclosed.

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Appendix 1: Translating Research into Action for Diabetes (TRIAD) Study Group

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Appendix 2: Clinical Care Strategy Intensity Measures

We describe how we constructed the physician performance feedback, intensity of physician reminders, and intensity of diabetes disease management scores. Scores were calculated for each health plan (HP) and physician group (PG).

Quantity of Physician Performance Feedback

To compute the physician performance feedback composite score, we counted the number of items checked on a list of 15 possible diabetes processes and outcomes that could be given back to physicians. After we averaged the counts over PGs and HPs separately, each group and plan count was then *z*-transformed.

Intensity of Physician Reminders

The physician reminders composite was constructed from 2 multi-item questions. One question described the type of reminder, and the second described its content.

Reminder Type

The PG/HP survey listed 6 types of reminders that organizations could send their clinicians. Each PG/HP was assigned a score between 0 and 5 that corresponded to the most intense reminder checked (no reminders sent, 0; preprinted guidelines only sent, 1; flowsheets sent, 2; flags on medical records sent, 3; mailed list of patients, 4; customized alerts on medical records, 5).

Reminder Content

The PG/HP surveys included 9 possible items that are commonly included in reminders. Each PG/HP reminder content score corresponded to the number of reminder items checked.

The sums for both the type and content scores were *z*-transformed, as was done for the feedback score. The 2 *z*-transformed scores were averaged to give the final score for composite reminders.

Structured Diabetes Care Management

The comprehensive disease management composite combined 4 domains: disease management programs, intensity of diabetes guideline use, intensity of patient reminders, and diabetes education.

Disease Management Programs

We considered 3 aspects of disease management: program implementation, intensity of disease management, and formal case management.

Program Implementation

A plan or group's score on this indicator was the number of years that it had had a diabetes disease management program multiplied by the proportion of patients with diabetes enrolled in each PG/HP. Scores were *z*-transformed.

Intensity of Disease Management

A plan or group's score was the number of 9 possible disease management strategies included in the disease management program. Scores were *z*-transformed.

Formal Case Management

This indicator had 2 components: the number of diabetes case managers per 10 000 patients and the intensity of case management. To obtain the score for intensity of case management, each PG/HP was assigned a score between 0 and 3 that corresponded to the most intense of the following strategies checked (no patients assigned to case managers, 0; assignments made by primary care physician referral or patient self-referral, 1; most costly patients, recently discharged patients, or patients at high risk for micro- or macrovascular complications assigned, 2; all patients assigned, 3). The intensity score and the number of case managers per 10 000 patients in each PG/HP were *z*-transformed and the 2 components summed.

The disease management score was the mean of the *z*-transformed program implementation, disease management intensity, and case management scores.

Intensity of Diabetes Guideline Use

Each PG/HP received a score between 0 and 4 that corresponded to the most intense strategy for implementing guidelines checked (no guidelines used, 0; guidelines given to patients in written form or as educational talks, 1; guidelines sent in written form to physicians, 2; guidelines provided to physicians in computerized form, 3; guidelines incorporated into physician reminders or automated patient reminders, 4). Scores were *z*-transformed.

Intensity of Patient Reminders

We combined 2 multi-item indicators for this measure. The first was a weighted patient reminders indicator, which summed 6 possible reminders that were weighted by how often the reminders were sent to patients. The second indicator was a score between 0 and 4 that corresponded to the most intense of 4 possible strategies for sending reminders (no reminders sent, 0; generic newsletters or HP newsletters sent, 1; letters sent to specific patients, 2; letters sent from primary care physicians to specific patients, 3; personal telephone calls made to patients, 4). Both reminder scores were *z*-transformed, and the mean of the *z*-transformed scores was the intensity of patient reminders composite score.

Diabetes Education

This composite was constructed from the following 3 items: whether or not the PG/HP sponsored group or individual diabetes education classes; the number of full-time equivalent certified diabetes educators that were employed by the PG/HP; and whether the PG/HP had a formal diabetes education program. Each of these 3 indicators was *z*-transformed; the diabetes education composite score for each PG/HP was the mean of the 3 *z*-transformed scores.

Combining the Composites into 1 Comprehensive Score

The scores for disease management, guidelines, patient reminders, and education were highly correlated; pairwise Pearson *r* values ranged from 0.63 to 0.88. To avoid multicollinearity, we combined these scores into an overall structured diabetes care management comprehensive diabetes disease management score. The mean of the *z*-transformed indicators within each composite (the 3 indicators in the disease management composite; the 1 indicator in the guidelines composite; the 2 indicators in the patient reminders composite; and the 3 indicators in the education composite) was the structured diabetes care management score for each PG/HP.

Appendix Table 1. **Descriptive Statistics for Each Clinical Care Strategy Composite**

Characteristic	Mean *z* Score (SD)	Range
Diabetes registry/intensity of use		
Health plan level	0 (0.93)	−0.85 to 1.37
Physician group level	0 (0.86)	−1.07 to 1.23
Quantity of physician feedback		
Health plan level	0 (1.00)	−0.69 to 2.08
Physician group level	0 (1.00)	−0.87 to 1.47
Intensity of physician reminders		
Health plan level	0 (0.98)	−0.71 to 1.87
Physician group level	0 (0.88)	−1.12 to 2.23
Diabetes disease management/guidelines/patient reminders/education		
Health plan level	0 (0.79)	−0.97 to 1.19
Physician group level	0 (0.83)	−1.14 to 1.05

Appendix Figure. **Translating Research into Action for Diabetes (*TRIAD*) Physician Group Survey.**

TRIAD Provider Group and Health Plan Survey*

*This document contains only the relevant items needed to calculate the main predictors described in this paper.

	Yes	No
1. Does your medical group (MG)/independent practice association (IPA) use algorithms or clinical guidelines? (If No, skip to Question 2)	☐	☐

1a. If you answered Yes to Question 1, do you use guidelines for the following diseases, and if so, what percent of your providers use these guidelines? *Give your best estimate.*

	Yes	No	Year implemented
Diabetes mellitus	☐	☐	_____
Post–myocardial infarction	☐	☐	_____
Acute myocardial ischemia	☐	☐	_____
Chronic myocardial ischemia	☐	☐	_____
Cholesterol management	☐	☐	_____
Depression	☐	☐	_____
Hypertension	☐	☐	_____
Smoking cessation	☐	☐	_____
Adult preventive care	☐	☐	_____
Prenatal care (including gestational diabetes)	☐	☐	_____

1b. If you answered Yes to 1a, which diabetes guidelines do you use: *(Circle all that apply)*

American Diabetes Association	☐
American Association of Clinical Endocrinologists	☐
Veterans Affairs	☐
Health plan	☐
Guidelines developed by your MG/IPA	☐
Other _____	☐

1c. How are diabetes guidelines implemented? Under rank, please indicate the most frequent use with a 1, the second most frequent mode with a 2, etc. *(Mark all that apply)*

		Rank
Written-form to MDs	☐	_____
Computerized form to MDs	☐	_____
Incorporated into MD reminders	☐	_____
Incorporated into automated patient reminders	☐	_____
Presented in educational talks	☐	_____
Directly communicated to patients in written form	☐	_____
Other	☐	_____

If other, please specify: _____

1d. How frequently are diabetes guidelines reviewed for change? _____ (eg, every 6 months)

1e. At the MG/IPA level, do you track clinician compliance with diabetes guidelines in a quantifiable way?

	Yes	No
Individual clinician level	☐	☐
Office practice level	☐	☐

(If No to both, skip to Question 2)

1f. If you answered Yes to Question 1e, has the MG/IPA documented change over time in compliance with guidelines:

	Yes	No
Individual clinician level	☐	☐
Office practice level	☐	☐

	Yes	No
1g. Is individual level compliance fed back to the provider?	☐	☐

1h. If you answered Yes to Question 1g, what year did you put this system into place? _____

	Yes	No
1i. Is aggregate data on compliance fed back to the provider at either the office level or some other aggregated unit?	☐	☐

1j. If you answered Yes to Question 1i, what year did you put this system into place? _____

1k. Which of the following processes and outcome variables for diabetes are fed back:

	Yes	No	Don't Know
Rates of hemoglobin A_{1c} testing	☐	☐	☐
Average hemoglobin A_{1c} level by provider	☐	☐	☐
Rates of dilated eye exams	☐	☐	☐
Rates of visits to nutritionist	☐	☐	☐
Rates of visits to diabetes educator	☐	☐	☐
Rates of visits to podiatrist	☐	☐	☐
Rates of serum LDL cholesterol testing	☐	☐	☐

Average serum LDL cholesterol level by provider	☐	☐	☐
Rates of microalbuminuria testing	☐	☐	☐
Rates of ACE inhibitor use	☐	☐	☐
Rates of aspirin use	☐	☐	☐
Rates of administration of influenza shots	☐	☐	☐
Rates of emergency department visits	☐	☐	☐
Rates of hospital admissions	☐	☐	☐
Other, describe_____	☐	☐	☐

2. What kinds of reminders do you send to clinicians who treat patients with diabetes? *(Check all that apply)*

	Yes	No	Year implemented	How often are they sent?
Preprinted guidelines for diabetes care	☐	☐	_____	_____
Diabetes-specific flow sheets for individual patients	☐	☐	_____	_____
Flag on the medical records of all diabetic patients	☐	☐	_____	_____
Customized alerts on the medical records on the day of a visit	☐	☐	_____	_____
Physician feedback after a visit	☐	☐	_____	_____
Mailed list of patients with needed services identified	☐	☐	_____	_____

(If No to all, skip to Question 4)

3. What are the contents of these reminders sent to physicians? *(Check all that apply)*

Glycohemoglobin due	☐
Lipid screen due	☐
Dilated eye exam due	☐
Renal screen due	☐
Foot exam due	☐
Reminder to consider ACE Inhibitor	☐
Reminder to consider ASA	☐
Reminder to consider lipid lowering treatment	☐
Flu shot due	☐

4. Does your MG/IPA send reminders directly to patients with diabetes about the need for: *(Check all that apply)*

Reminder		How often reminded? (Pick the answer that is closest to what you actually do.)				
Check if yes		Semi-annually	Annually	Every 2 years or more	Only if overdue	Only to newly diagnosed diabetics
Glycohemoglobin due	☐	☐	☐	☐	☐	☐
Lipid screen due	☐	☐	☐	☐	☐	☐
Dilated eye exam due	☐	☐	☐	☐	☐	☐
Kidney test due	☐	☐	☐	☐	☐	☐
Flu shot due	☐	☐	☐	☐	☐	☐
Foot exam due	☐	☐	☐	☐	☐	☐

5. What types of reminders do you send to patients? *(Check all that apply)*

"Generic" letter	☐
Letter addressed to specific patients	☐
Letter from patient's provider	☐
Telephone calls to patients	☐
Plan newsletters to patients/doctors	☐
Other, describe_____	☐

	Yes	No
6. Does your MG/IPA sponsor group or individual diabetes educational classes? (If No, skip to Question 7)	☐	☐

6a. If yes, what proportion of your diabetic patients attend these classes in a given year? _____%

6b. Is there any cost sharing for diabetes educational classes at the patient level? *(Circle appropriate number in the corresponding row)*

	Commercial	Medicare	Medicaid
Never	1	1	1
Rarely	2	2	2
Sometimes	3	3	3
Usually	4	4	4
Always	5	5	5

6c. If you answered sometimes, usually, or always for any of the boxes in 6b, what is the approximate amount per class? *(Indicate answer in dollar amount)*

Commercial	Medicare	Medicaid
$	$	$

6d. How many classes per year are offered as a covered benefit? *(Indicate answer as a number)*

Commercial	Medicare	Medicaid

7. Does your MG/IPA cover smoking cessation classes? (If No, skip to Question 8) — Yes ☐ No ☐

7a. Is there any cost sharing for smoking cessation classes at the patient level? *(Circle appropriate number in the corresponding row)*

	Commercial	Medicare	Medicaid
Never	1	1	1
Rarely	2	2	2
Sometimes	3	3	3
Usually	4	4	4
Always	5	5	5

7b. If you answered sometimes, usually, or always for any of the boxes in 7a, what is the approximate amount per class? *(Indicate answer in dollar amount)*

Commercial	Medicare	Medicaid
$	$	$

8. Do you have any instructors who are Certified Diabetes Educators (CDE) who are employed by the medical group? (If No, skip to Question 9) — Yes ☐ No ☐ Don't Know ☐

8a. How many are full-time employees? _____

8b. If not employed by provider group are they contracted out? — Yes ☐ No ☐ Don't Know ☐

9. Does your provider group have a diabetes education program? (If No, skip to Question 10) — Yes ☐ No ☐

9a. Does your program cover the following content areas: *(Check if Yes)*

- Don't know the content of the program ☐
- Nutrition ☐
- Exercise ☐
- Medications ☐
- Monitoring and use of blood sugar results ☐
- Relationships among nutrition, exercise, medication and blood glucose levels ☐
- Foot and skin care ☐
- Dental care ☐
- Behavior change strategies ☐
- Goal setting ☐
- Smoking cessation ☐
- Benefits, risks, and management options for improving glucose control ☐
- Preconception care and diabetes pregnancy care ☐
- Use of health care systems and community resources ☐

10. Does your MG/IPA have disease management programs* for patients with chronic diseases? — Yes ☐ No ☐

*A disease management program is one that identifies most or all persons with a condition, monitors their quality of care, and provides condition-specific outreach and education to patients and/or providers

10a. Does your MG/IPA have a disease management program for patients with diabetes? (If No, skip to Question 11) — Yes ☐ No ☐

10b. What year was the diabetes program implemented? _____

10c. Estimate the percentage of patients with diabetes who are enrolled. _____%

10d. What elements are included in the diabetes management program? *(Mark all that apply)*

- Individual counseling ☐
- Group classes ☐
- Disease management specialist available by telephone around the clock ☐
- Proactive outbound calls at a regular interval for high-risk patients ☐
- Cluster visits* ☐
- Use of self-management materials (eg, mail or videos) ☐
- Element of specialist referral as part of case management ☐
- Identification of patients who are at high risk for poor self-management ☐
- Linkage of high-risk patients to physicians who specialize in the condition ☐

*Cluster visits: Group visits for patients with the primary care physician or other care provider. Visits can include: discussion of patient concerns, preventive measures like eye and foot examinations, and adjustment of medications.

10e. Are there aspects of your diabetes disease management program that were not included in the list above? Please describe:

_____

_____

_____

_____

	Yes	No
11. Does your MG/IPA use ambulatory diabetes case managers who coordinate care among diabetic patients? *(If no, skip Questions 11a through 11c)*	☐	☐

11a. Which diabetic patients cared for by your MG/IPA are assigned to diabetes case managers? *(Check all that apply)*

- All diabetic patients ☐
- Patients whose conditions are most costly to treat ☐
- Recently discharged patients ☐
- Those at high risk for micro/macrovascular complications ☐
- Primary care physician preference ☐
- Patient preference ☐
- Other specific utilization ☐

Describe:_____

11b. Which personnel are dedicated to diabetes-specific case management, and how many are devoted to this role exclusively?

Role	Personnel Involved in Case Management	Total Full-Time Employees Dedicated to Case Management (% Time × *N* persons)
Physicians		
Nurses		
Nurse practitioners		
Registered nurses		
Licensed practical nurses		
Physician assistant		
Certified diabetes educators		
Other health educators		
Other personnel		
Total		

11c. Approximately how many patients are assigned to each diabetes case manager? _____

ACE = angiotensin-converting enzyme; ASA = aspirin; LDL = low-density lipoprotein.

Appendix Table 2. **Adjusted Association of Physician Group Disease Management with Quality Indicators, Intermediate Outcome Levels, and Medical Management of Intermediate Outcomes (Third, Second, and First Tertiles)***

Dependent Variables	Structured Care Management				Performance Feedback			
	Tercile			Difference for Third Minus First (95% CI)†	Tercile			Difference for Third Minus First (95% CI)†
	Third	Second	First		Third	Second	First	
Quality indicator, %								
Dilated retinal examination	81	81	73	**8 (2 to 14)**	83	78	76	**6 (2 to 10)**
Nephropathy screening	82	79	71	**11 (1 to 21)**	84	75	74	**10 (5 to 16)**
Foot examination	87	88	80	**7 (0 to 13)**	88	84	83	**5 (1 to 8)**
Hemoglobin A_{1c} test	88	87	79	**9 (4 to 15)**	90	87	82	**8 (5 to 12)**
Lipid panel tested	75	68	65	**10 (3 to 17)**	75	76	68	**7 (3 to 12)**
Influenza vaccine advised	69	70	60	**9 (1 to 16)**	70	65	64	**6 (1 to 11)**
Aspirin therapy advised	50	56	50	0 (−7 to 8)	55	52	52	3 (−2 to 8)
Smoking cessation advised†	92	88	90	2 (−4 to 7)	92	89	89	3 (−1 to 7)
Mean intermediate outcomes								
Hemoglobin A_{1c} level, %	8.0	8.0	7.9	0.1 (−0.3 to 0.4)	8.0	7.8	8.0	0.0 (−0.3 to 0.3)
Systolic blood pressure, *mm Hg*	138	136	135	**3 (1 to 5)**	136	134	136	0 (−2 to 2)
Serum LDL cholesterol level								
mmol/L§	2.95	2.95	2.90	0.05 (−0.10 to 0.20)	3.00	2.90	2.90	0.10 (0 to 0.15)
mg/dL	114	114	113	1 (−4 to 7)	115	112	113	2 (0 to 5)
Patients at target levels or receiving more therapy, %‖								
Hemoglobin A_{1c}	90	93	94	**−4 (−8 to 0)**	93	95	93	0 (−1 to 2)
Systolic blood pressure	74	80	76	−2 (−10 to 5)	77	80	78	−1 (−3 to 6)
Serum LDL cholesterol	84	80	81	3 (0 to 11)	80	80	82	−2 (−7 to 3)

* Predicted percentages/values in each dependent variable for third, second, and first terciles of disease management intensity score, and third versus first tercile differences between predicted percentages/values. Separate hierarchical models performed for each disease management strategy and each dependent variable. For quality indicators, models are adjusted for patient age, sex, ethnicity, education, income, current diabetes treatment, duration of diabetes, Charlson index score, history of cardiovascular disease, physical component score of the Short Form-12, and health plan intensity for same predictor. For intermediate outcome levels and medication use models, we omitted current treatment and the Short Form-12 physical component score as adjusters. Values shown in boldface are statistically significant. LDL = low-density lipoprotein.
† Difference in adjusted predicted values at third versus first tercile of the disease management intensity score.
‡ Model includes only the 1386 persons who were current smokers.
§ Lower/upper confidence limit of zero is a negative value that was rounded to zero.
‖ Medication use models for systolic blood pressure and serum LDL cholesterol were restricted to 6520 and 4534 persons with diagnoses of hypertension and hyperlipidemia, respectively.

Appendix Table 2—**Continued**

Physician Reminders				Combined Score			
Tercile			Difference for Third Minus First (95% CI)†	Tercile			Difference for Third Minus First (95% CI)†
Third	Second	First		Third	Second	First	
83	80	73	**10 (6 to 15)**	83	78	74	**9 (4 to 14)**
83	82	68	**15 (6 to 23)**	84	79	69	**15 (6 to 24)**
88	87	80	**8 (2 to 14)**	88	88	80	**8 (1 to 15)**
88	89	79	**8 (4 to 13)**	89	87	78	**11 (5 to 17)**
70	69	66	5 (−3 to 12)	75	68	67	**8 (2 to 15)**
67	66	62	5 (−1 to 11)	67	67	63	4 (−4 to 11)
56	59	48	**8 (2 to 13)**	56	59	47	**9 (2 to 16)**
91	92	88	3 (−2 to 7)	92	88	90	2 (−3 to 7)
8.0	8.0	8.0	0.0 (−0.3 to 0.3)	8.0	8.0	7.9	0.1 (−0.2 to 0.4)
137	135	136	1 (−1 to 3)	138	136	136	**2 (0 to 4)**
2.90	2.90	3.00	**−0.10 (−0.10 to 0)**	2.95	2.90	2.95	0 (−10 to 0.10)
113	112	115	**−2 (−3 to 0)**	114	113	114	0 (−4 to 4)
92	93	94	−2 (−4 to 0)	91	92	94	−3 (−7 to 0)
77	81	76	1 (−4 to 7)	77	78	77	0 (−7 to 7)
84	84	77	**7 (1 to 13)**	84	82	80	4 (0 to 11)