

Veterans Affairs Primary Care Organizational Characteristics Associated With Better Diabetes Control

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Objective: To examine organizational features of Veterans Affairs (VA) primary care programs hypothesized to be associated with better diabetes control, as indicated by hemoglobin A_{1c} (HbA_{1c}) levels.

Study Design: Cross-sectional cohort.

Methods: We established a cohort of 224 221 diabetic patients using the VA Diabetes Registry and Dataset and VA corporate databases. The 1999 VHA (Veterans Health Administration) Survey of Primary Care Practices results were combined with individual patient data. A 2-level hierarchical model was used to determine the relationship between organizational characteristics and HbA_{1c} levels in 177 clinics with 82 428 cohort members.

Results: The following attributes were associated with lower (better) HbA_{1c} and were statistically significant at $P < .05$: greater authority to establish or implement clinical policies (lower by 0.21%), greater staffing authority (0.28%), computerized diabetes reminders (0.17%), notifying all patients of their assigned provider (0.21%), hiring needed new staff during fiscal year 1999 (0.18%), having nurses that report only to the program (0.16%), and being a large academic practice (0.27%). Associated with higher (worse) HbA_{1c} were programs reporting that patients almost always see their assigned provider (greater by 0.18%), having a quality improvement program involving all nurses without all physicians (0.38%), having general internal medicine physicians report only to the program (0.20%), and being located at an acute care hospital (0.20%).

Conclusion: Programs that are associated with better diabetes control simultaneously have teams that actively involve physicians in quality improvement, use electronic health information systems, have authority to respond to staffing and programmatic issues, and engage patients in care.

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The quality and outcomes of healthcare in the United States are far from optimal.¹⁻⁴ The chronic care model⁵ posits that optimum chronic illness management requires a healthcare system that provides self-management support to patients, decision support, clinical information systems that support care, and effective connections with community resources. Such a system can improve interactions between

providers and patients and, in turn, enhance patient outcomes. The model proposes a basic road map for combining these elements to achieve optimal patient outcomes.⁵⁻¹²

Several features of the Veterans Health Administration (VHA) make it an ideal system in which to test features of the chronic care model. First, the VHA operates the largest integrated healthcare delivery system in the United States.¹³ Second, in the mid-to-late 1990s, the VHA was transformed from a system with an inpatient specialty treatment focus to one that emphasizes primary care and integrated practice teams.¹⁴⁻¹⁶ Third, the VHA's extensive electronic medical record system facilitates care and provides the opportunity to examine the relationship between the organization of primary care and chronic disease outcomes. Therefore, study of Veterans Affairs (VA) health systems offers large-scale sources of data for understanding managed care delivery.¹⁷⁻¹⁹

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Diabetes mellitus is an excellent disease for testing the chronic care model. Diabetes mellitus is prevalent in the United States: 12 million adults have diagnosed diabetes mellitus, and another 6 million have undiagnosed diabetes mellitus.²⁰ Persons with diabetes mellitus are at increased risk for macrovascular and microvascular complications that compromise patients' quality of life and result in extensive use of healthcare services.²⁰⁻²⁴ Given its prevalence, morbidity, and associated health services use, diabetes mellitus is estimated to cost the United States \$132 billion annually.²⁵ The significance of diabetes mellitus in the VHA mirrors or exceeds that in the rest of the United States.²⁶⁻³⁴ For example, diabetes mellitus accounts for 25% of all pharmacy costs and 1.7 million inpatient bed days each year in the VHA.³¹

The morbidity and costs of diabetes mellitus can be reduced by tight control of blood sugar.³⁵⁻³⁸ However, adequate blood sugar control is often not achieved among adults with diabetes mellitus.³⁹⁻⁴¹ Furthermore, the VHA External Peer Review Program and the National Committee on Quality Assurance's Health Employer Data and Information Set (HEDIS) include provision of hemoglobin A_{1c} (HbA_{1c}) tests and control of HbA_{1c} among performance measures.⁴²

The present study seeks to identify organizational characteristics of primary care programs that are associated with glycemic control and, hence, a reduced risk of long-term diabetes complications. Although not all characteristics of the chronic care model were measured, we hypothesized that those programs that more closely approximated this type of optimal system would have patients with better glycemic control.

METHODS

We studied the effect of primary care organization during fiscal year (FY) 1999, which covers October 1, 1998 through September 30, 1999. In FY 1999, the VHA included 172 hospitals, more than 600 outpatient clinics, 132 nursing homes, 40 domiciliaries, 73 comprehensive home care programs, and 206 counseling centers.¹⁶ That year, 3.7 million people received care through the VHA.⁴³ The institutional review board of the Durham Veterans Affairs Medical Center approved the study protocol.

Data Sources

1999 VHA Survey of Primary Care Practices. Information on the organization of VHA primary care clinics was obtained from the 1999 VHA Survey of Primary Care Practices.^{44,45} Between October and December 1999, the survey was sent to clinical leaders

of primary care programs at individual VHA facilities with at least 4000 unique patients and at least 20 000 outpatient visits in FY 1998. This included 170 VA medical centers and 65 community-based outpatient clinics. The objective was to evaluate the organizational features of primary care programs so as to elucidate the relationships among organizational features and clinical and economic outcomes. There were 219 responses (160 medical centers and 59 community-based outpatient clinics), a response rate of 93%.^{44,45}

VA Diabetes Registry and Dataset. The VA Diabetes Registry and Dataset was used to establish the cohort of diabetic patients and obtain outcome data.⁴⁶ During FY 1999, 503 371 patients were in the registry.⁴⁷ The registry contains 3 files. The *pharmacy file* has information on patients who have ever had prescriptions filled at a VA pharmacy for insulin, oral hypoglycemic agents, or blood glucose monitoring supplies. The *laboratory file* contains test results directly related to diabetes care. The *vital signs file* has information on patient height, weight, body mass index, blood pressure, and receipt of influenza and pneumonia vaccines.⁴⁶

Veterans Affairs Corporate Databases. Data on patient demographics, healthcare use, comorbidities, and vital status were obtained from multiple VA corporate databases housed at the VA Austin Automation Center, Austin, Tex. Most databases maintained at the VA Austin Automation Center result from downloads from individual Veterans Information System Technologies Architecture health information systems located at VHA facilities.^{48,49} The VA Austin Automation Center has data on all VHA inpatient and outpatient encounters since 1980.^{50,51} Vital status of veterans is recorded in the Beneficiary Identification and Record Locator System.⁵² Information on patient comorbidities used for risk adjustment is located in The Johns Hopkins Adjusted Clinical Groups Case-Mix System files.⁵³

Subjects

Using the VA Diabetes Registry and Dataset, we identified patients who met the following inclusion criteria during FY 1999: (1) had at least 2 non-mental health outpatient visits with an associated diagnosis of diabetes mellitus, or any non-mental health inpatient discharge with an associated diagnosis of diabetes mellitus; (2) had a prescription filled for insulin, an oral hypoglycemic agent, or blood glucose monitoring supplies (from the VA Diabetes Registry and Dataset pharmacy file); and (3) had at least 1 outpatient visit to a VA primary care clinic. Exclusion criteria were age younger than 18 years, switching primary VA facilities during the study period, any VA endocrinology visit during FY 1999 through FY 2001, and pregnancy.

Encounter data were obtained from the inpatient bed section and outpatient event files. Specific *International Classification of Diseases, Ninth Revision, Clinical Modification* codes used to identify patients with diabetes mellitus were obtained from the 2003 version of the Clinical Classifications Software from the Agency for Healthcare Research and Quality.⁵⁴

Individuals were considered primary care patients of the VA facility where they made the greatest number of primary care visits during FY 1999. In case of a tie, the patient was randomly assigned to one of the tied locations. Once patients' primary care clinics were determined, a random sample of 800 diabetic patients meeting the inclusion criteria was drawn from each VA facility operating in FY 1999. If a location did not have 800 patients meeting the criteria, all eligible patients were retained. The **Figure** illustrates the process of developing the diabetic cohort.

Outcomes

Our outcome was HbA_{1c}, which measures mean glucose control during approximately 120 days.⁵⁵ Results from facilities that measured total glycosylated hemoglobin (an older measure of glycemic control) were converted to HbA_{1c} using the laboratory equipment manufacturer's conversion formula. During the study period, the VA considered HbA_{1c} of 7.0% or higher to be elevated to a concerning level; levels of 9.0% or higher were considered markedly elevated.²⁷ Specifically, the study modeled the associations among organization-level and individual-level independent variables and the last HbA_{1c} value obtained during the study period of FY 2000 through FY 2001 (October 1, 1999, through September 30, 2001).

Organizational-level Variables

The present study used a hypothesis-driven model building approach that captures the elements of the chronic care model that we hypothesized to be related to better diabetes control. From the 1999 VHA Survey of Primary Care Practices, we used 5 scales related to the implementation of managed care, defined as arrangements "implemented to influence clinicians' healthcare service utilization decisions."^{56,p1} *Gatekeeping* measures the degree to which primary care providers maintain a level of control over referrals for specialty services, tests, and treatments (eg, patients having the ability to self-refer for specialty services indicates less use of gatekeeping than not allowing such referrals). *Preauthorization* measures the degree to which providers must formally request approval to provide certain types of specialized services. *Profiling* is the degree to which clinics monitor and report use of

specific services by individual providers. The *guideline scale* measures the degree to which clinics use evidence-based guidelines and mechanisms to implement the guidelines. The *education scale* indicates the level of use of educational programs aimed at encouraging clinicians to use evidence-based or cost-effective services.

The survey also contains 3 scales that measure the degree of primary care program authority.⁵⁷ The *clinical practice autonomy scale* represents the authority of the program to set clinical policies and implement care guidelines. *Primary care staffing authority* indicates the authority of the program to select, evaluate, and arrange the work of staff members. The *primary care organizational influence and ability to form interorganizational alliances scale* addresses the authority of the program to establish relationships with other groups within and outside the VA facility.

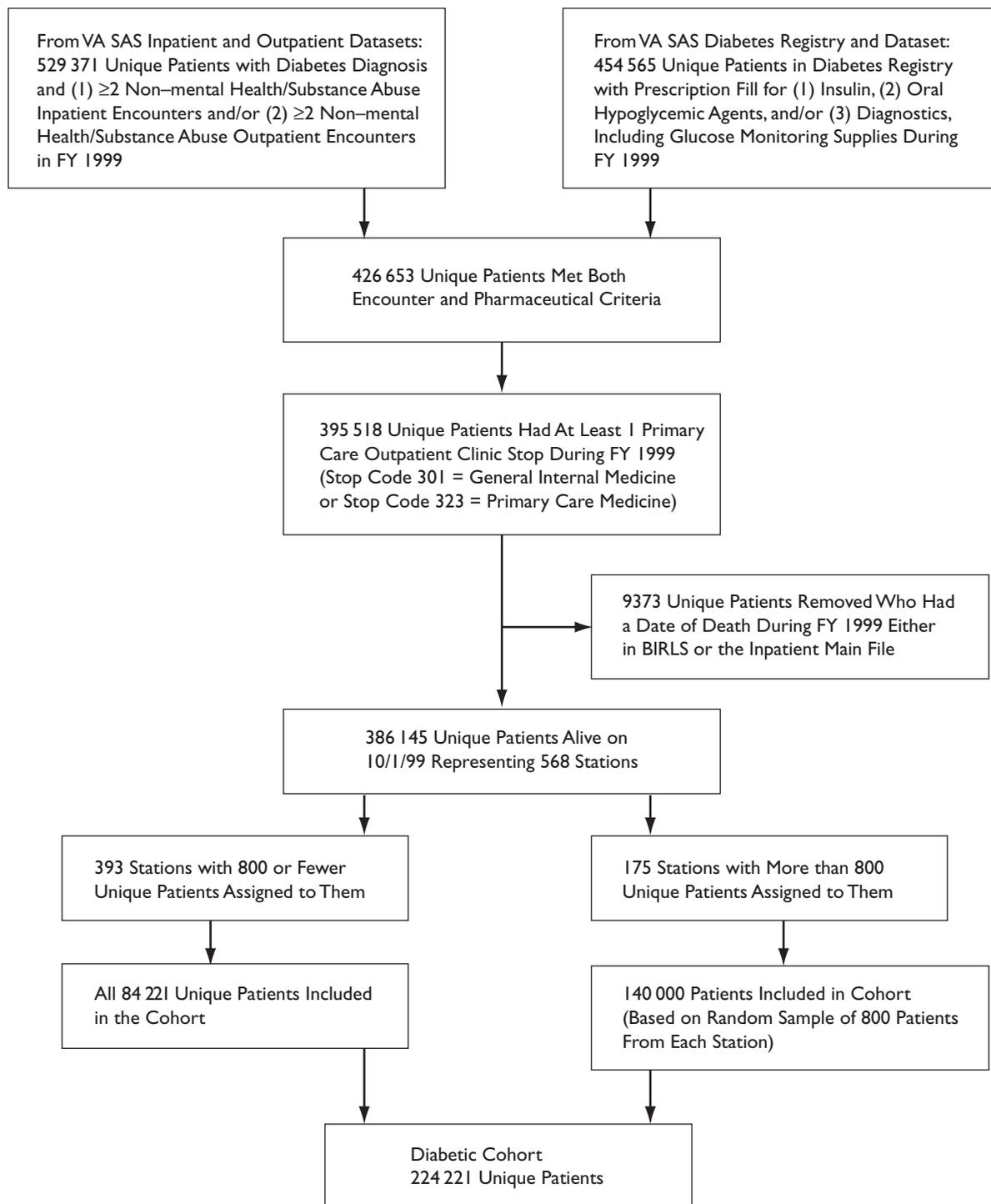
Beyond these scales, the 1999 VHA Survey of Primary Care Practices assesses the following organizational characteristics: (1) use of computerized provider reminders for diabetes care; (2) presence of multidisciplinary teams that meet at least once a week to make patient care decisions; (3) use of special-purpose teams or protocols developed for designated clinical conditions (eg, diabetes mellitus) or patient groups (eg, homeless persons); (4) notification of all or almost all patients of their assigned primary care provider; (5) indication that patients almost always see their assigned provider (defined by the survey respondent at each site); (6) use of some type of provider recognition for quality care; and (7) indication that in the year before the survey (FY 1999) the clinic hired needed new staff.

Data regarding physician and nurse involvement in quality improvement (QI) were captured by 3 variables that indicate whether a clinic reported that (1) all physicians and all nurses participate in QI initiatives, (2) all physicians but not all nurses participate, or (3) all nurses but not all physicians participate. The referent group includes clinics in which neither all nurses nor all physicians participate.

Two variables captured the reporting relationship between staff and the primary care program. One variable indicated whether the program has general internal medicine physicians who report only to the program. The other indicated whether the program has nurses who report only to the program. The relationship between these organizational attributes and the chronic care model is outlined in **Table 1**.

Finally, in addition to characteristics that may be sensitive to administrative and clinical actions, other organizational attributes were used to adjust results for the clinical environment. These included (1) region of the country, (2) number of reported primary care

Figure. Process of Combining Data on Patients Meeting Encounter and Prescription-based Eligibility Criteria to Define the Diabetic Cohort



BIRLS indicates Beneficiary Identification and Record Locator System; FY, fiscal year; VA, Veterans Affairs.

provider full-time equivalents (attending physicians, resident physicians, and midlevel practitioners), (3) whether the clinic is a large academic practice with more than 30 internal medicine house officers, and (4) whether the clinic is based at an acute care hospital.

Individual-level Variables

Risk adjustment for comorbidities was done using aggregated diagnostic groups, which are part of The Johns Hopkins Adjusted Clinical Groups Case-Mix System.^{53,58} In addition, results were adjusted for the following patient-level characteristics: age, sex, race or ethnicity, marital status, body mass index (on the closest date to October 1, 1999), VA eligibility means test category (partial proxy for socioeconomic status), service-connected disability rating, number of visits to the assigned clinic during the FY in which the outcome HbA_{1c} value was recorded, whether the patient filled a prescription for insulin during the FY in which the outcome HbA_{1c} value was recorded, and whether the patient filled a prescription for an oral hypoglycemic agent during the FY in which the outcome HbA_{1c} value was recorded.

Data Analysis

The present study dealt specifically with patients of facilities that replied to the 1999 VHA Survey of Primary Care Practices and provided complete data on the organizational characteristics under study. Three

Table 1. Relationship Between Organizational-level Study Variables and the Chronic Care Model*

Organizational Attribute	Variable [†]
Overall chronic care model concept of organization of healthcare	
Commitment to chronic illness care (incentives)	Provider recognition for quality care
Commitment to chronic illness care (staffing)	Facility hired needed new staff in fiscal year 1999
Ability to respond to clinic needs	Clinical practice autonomy Primary care staffing authority Primary care organizational influence and ability to form interorganizational alliances
Delivery system design	
Teams	Teams consisting of multiple professions meet at least once a week Use of teams or protocols developed for specific purposes Program reports having general internal medicine physicians that only report to the primary care program Program reports having nurses that only report to the primary care program Primary care staffing authority
Practice team leadership and participation in quality improvement initiatives	All physicians and all nurses participate All physicians but not all nurses participate All nurses but not all physicians participate
Continuity	Primary care organizational influence and ability to form interorganizational alliances Program reports patients of clinic almost always see assigned primary care provider Use of gatekeeping (may or may not improve continuity) Use of preauthorization (may or may not improve continuity)
Engaging patients in care	Program reports all patients notified of provider assignments
Decision support	
Use and support of evidence-based guidelines	Use of clinical practice guidelines Use of provider education strategies Use of computerized reminders for preventive diabetes care Clinical practice autonomy (including authority to establish practice guidelines)
Clinical information systems	
Use of information technology in diabetes care	Use of computerized reminders for preventive diabetes care
Feedback	Profiling of providers

*Chronic care model by Wagner et al.⁹

[†]The same variable can appear under multiple categories.

Table 2. Organizational Characteristics of 177 Primary Care Programs Included in the Final Hierarchical Statistical Model*

Characteristic	Value
Teams	
Teams consisting of multiple professions meet at least once a week to make decisions about patient care	32.2
Use of teams or protocols developed for specific purposes	57.1
Participation of nurses and physicians in quality improvement programs	
Not all physicians and not all nurses participate	59.9
All physicians but not all nurses participate	7.3
All nurses but not all physicians participate	6.2
All physicians and all nurses participate	26.6
Information technology	
Use of computerized provider diabetes preventive care reminders	66.1
Engaging patients in care	
Program reports all patients are notified of provider assignments	84.8
Continuity of care	
Program reports patients of clinic almost always see assigned primary care provider	58.2
Incentives	
Provider recognition for quality care	41.8
Responding to staffing needs	
Program hired needed new staff in FY 1999	72.3
Staff-reporting arrangements	
Program reports having general internal medicine physicians that only report to the primary care program	57.6
Program reports having nurses that only report to the primary care program	53.1
Overall facility characteristics	
Primary care program located at acute care hospital	70.6
Program reports having internal medicine residents	50.3
Large academic primary care practice (> 30 internal medicine house staff physicians)	31.6
Regions of the country	
Northeast	21.5
Midwest	26.0
Southeast	29.4
West	23.2
Program size (visits)	
No. of outpatient visits to facility general medicine clinics in FY 1999, mean (SD)	31 261.7 (19 780.6)
% of facility outpatient visits that were to the general medicine clinics in FY 1999, mean (SD)	25.6 (11.7)
Program size (providers)	
No. of reported primary care provider full-time equivalents, mean (SD)	43.5 (48.3)

Abbreviation: FY, fiscal year.

*Data are given as percentages unless otherwise indicated.

of these clinics were not included because of the potential for incomplete downloads of HbA_{1c} data.

Hierarchical linear modeling was used to examine the associations among the last HbA_{1c} value during the study period of FY 2000 through FY 2001 (outcome [dependent variable] and independent variables occurring at the orga-

nizational and individual levels. Organizational variables are the focus of the study, and individual-level variables provide an opportunity to risk-adjust the organizational-level results. For each scale, the clinics included in the analysis were categorized by quartiles. The model includes variables that allow each scale quartile to be compared with the lowest quartile. Hierarchical modeling allows one to simultaneously consider the effects of group-level and individual-level variables on individual-level outcomes.⁵⁹⁻⁶² The hierarchical model was fit using the MIXED procedure of SAS version 8.2.⁶³ The 2-level model considered patients (individual level) to be clustered within clinics (organizational level).

The model reported for the present study does not allow slope coefficients for individual-level independent variables to vary across clinics. When the model was run allowing coefficients to vary across facilities, almost none of the random effects were statistically significant. Those that were did not have a practical effect on model fit.

RESULTS

The analysis included 177 primary care programs and 82 428 patients, with a mean HbA_{1c} of 7.6%. The mean number of patients per clinic was 466 (range, 34-690). **Table 2** provides characteristics of the primary care programs, and **Table 3** describes attributes of study patients.

Table 4 includes detailed results for the association between organizational structure and processes and HbA_{1c}. Differences across clinics accounted for 5.04% of the variance in HbA_{1c} (not equivalent to an R² for the covariants). The following attributes were associated with lower (better) HbA_{1c} and were statistically significant at *P* < .1: greater authority to establish or implement clinical policies (lower by 0.21% [third scale quartile compared with the lowest]), greater staffing authority (0.28% [highest scale quartile compared with the lowest]), greater use of gatekeeping (0.16% [highest scale quartile compared with the lowest]), computerized diabetes reminders (0.17%), special teams or protocols to respond to clinical issues (0.13%), weekly meetings of multidisciplinary clinical teams (0.12%), all physicians but not all nurses involved in QI (0.25%), notifying all patients of their assigned provider (0.21%), hiring needed new staff during FY 1999 (0.18%), having nurses that report only to the program (0.16%), and being a large academic practice (0.27%). Associated with higher (worse) HbA_{1c} were programs reporting that patients almost always see their assigned provider (greater by 0.18%), having a QI program involving all nurses without all physicians (0.38%), having general internal medicine

Table 3. Characteristics of 82 428 Patients Included in the Final Hierarchical Statistical Model*

Characteristic	Value
Age in FY 2000, mean (SD), y	65.5 (10.8)
Sex	
Male	98.0
Female	2.0
Race	
African American	11.7
American Indian	0.4
Asian	0.5
Hispanic (black)	0.2
Hispanic (white)	3.0
White	55.5
Unknown	28.6
Marital status in FY 2000	
Married	63.0
Widowed	7.3
Divorced	18.5
Separated	0.0
Never married	9.8
Unknown	1.5
VA eligibility means test category in FY 2000 [†]	
Required to pay copayments	10.4
Veterans treated for service-connected conditions or in special categories (do not pay copayments)	34.1
Veterans without service-connected injuries not required to pay copayments because of low income	54.1
Nonveteran	0.5
Veterans not required to complete means test	1.0
Service-connected disability rating in FY 2000, %	
0-9	67.0
10-49	18.7
50-99	8.5
100	5.8
No. of primary care visits to clinic during baseline FY of 1999, mean (SD)	4.6 (3.5)
No. of primary care visits to assigned clinic during FY in which the outcome HbA _{1c} measurement was taken	4.3 (3.4)
Last HbA _{1c} during the follow-up of FY 2000 through FY 2001, mean (SD), %	7.6 (1.7)
Body mass index closest to baseline date of October 1, 1999, mean (SD), kg/m ²	30.7 (6.0)
ADGs per patient, mean (SD) [‡]	7.2 (3.6)
Pharmaceutical treatment for hyperglycemia during FY in which the outcome HbA _{1c} measurement was taken	
Filled prescription for insulin	36.0
Filled prescription for oral hypoglycemic agent	76.5

ADG indicates aggregated diagnostic group; FY, fiscal year; HbA_{1c}, hemoglobin A_{1c}; VA, Veterans Affairs. *Data are given as percentages unless otherwise indicated.

[†]For a fuller description of the VA eligibility codes, see VA Information Resource Center: *The Medical SAS Outpatient Datasets-FY2000: A VIREC Resource Guide*. Hines, Ill: VA Information Resource Center; 2001. Available at: <http://www.virec.research.med.va.gov/References/RUG/RUG-Outpatient00.pdf>. Accessed December 10, 2004.

[‡]An individual was considered to be in the ADG if the person was in the ADG for either FY 2000 or FY 2001.

Table 4. Relationship Between Characteristics of Veterans Health Administration Primary Care Programs and Last HbA_{1c} Value During Follow-up of FY 2000 through FY 2001 Among 177 Clinics and 82 428 Patients*

Characteristic	HbA _{1c} Value Compared with Referent Group	P
Model intercept for fixed effects	9.70 (0.23)	< .01
Program Authority Scales		
Clinical practice autonomy scale		
First quartile	Referent	
Second quartile	-0.13 (0.09)	
Third quartile	-0.21 (0.09)	< .05
Fourth quartile	-0.14 (0.10)	
Primary care staffing authority scale		
First quartile	Referent	
Second quartile	-0.28 (0.09)	< .01
Third quartile	-0.27 (0.10)	< .01
Fourth quartile	-0.28 (0.10)	< .01
Primary care organizational influence and ability to form interorganizational alliances		
First quartile	Referent	
Second quartile	-0.047 (0.091)	
Third quartile	0.040 (0.090)	
Fourth quartile	0.090 (0.098)	
Managed Care Process Scales		
Gatekeeping scale		
First quartile	Referent	
Second quartile	-0.04 (0.10)	
Third quartile	0.028 (0.092)	
Fourth quartile	-0.16 (0.08)	< .10
Preauthorization scale		
First quartile	Referent	
Second quartile	0.009 (0.091)	
Third quartile	0.031 (0.094)	
Fourth quartile	-0.017 (0.094)	
Profiling scale		
First quartile	Referent	
Second quartile	0.092 (0.088)	
Third quartile	0.056 (0.096)	
Fourth quartile	0.13 (0.11)	
Guideline use scale		
First quartile	Referent	
Second quartile	0.04 (0.10)	
Third quartile	-0.16 (0.41)	
Fourth quartile	0.08 (0.12)	
Provider education strategies scale		
First quartile	Referent	
Second quartile	-0.0075 (0.114)	
Third quartile	-0.043 (0.097)	
Fourth quartile	-0.02 (0.10)	
Teams		
Teams consisting of multiple professions meet at least once a week to make decisions about patient care	-0.12 (0.07)	< .10
Use of teams or protocols developed for specific purposes	-0.13 (0.07)	< .10
Participation of Nurses and Physicians in Quality Improvement Programs		
Not all physicians and not all nurses participate	Referent	
All physicians and all nurses participate	-0.05 (0.07)	
All physicians but not all nurses participate	-0.25 (0.13)	< .10
All nurses but not all physicians participate	0.38 (0.13)	< .01

(Continued)

Table 4. Relationship Between Characteristics of Veterans Health Administration Primary Care Programs and Last HbA1c Value During Follow-up of FY 2000 through FY 2001 Among 177 Clinics and 82 428 Patients* (Continued)

Characteristic	HbA _{1c} Value Compared With Referent Group	P
Information Technology		
Use of computerized provider diabetes preventive care reminders	-0.17 (0.08)	< .05
Engaging Patients in Care		
Program reports all patients notified of provider assignments	-0.21 (0.09)	< .05
Continuity of Care		
Program reports patients of clinic almost always see assigned primary care provider	0.18 (0.07)	< .01
Incentives		
Provider recognition for quality care	0.07 (0.70)	
Responding to Staffing Needs		
Program hired needed new staff in FY 1999	-0.18 (0.07)	< .05
Staff-reporting Arrangements		
Program reports having general internal medicine physicians that only report to the primary care program	0.20 (0.08)	< .05
Program reports having nurses that only report to the primary care program	-0.16 (0.07)	< .05
Overall Facility Characteristics		
Primary care program located at acute care hospital	0.20 (0.08)	< .05
Large academic primary care practice (>30 internal medicine house staff physicians)	-0.27 (0.11)	< .05
Regions of the Country		
Northeast	Referent	
Midwest	-0.070 (0.094)	
Southeast	-0.11 (0.10)	
West	0.05 (0.10)	
Program Size (Attending General Internal Medicine Physicians)		
No. of reported primary care provider full-time equivalents (per 10 additional providers)	0.020 (0.011)	< .10

FY indicates fiscal year; HbA_{1c}, hemoglobin A_{1c}.

*Data are given as model coefficients/expected differences in HbA_{1c} (SE). Also adjusted for the following patient characteristics: (1) Johns Hopkins Aggregated Diagnostic Groups, (2) age (continuous variable), (3) sex, (4) race/ethnicity (African American, American Indian, Asian, Hispanic [black], Hispanic [white], and unknown, with white race as referent category), (5) marital status (widowed, divorced, separated, never married, and unknown, with married as referent category), (6) Veterans Affairs eligibility means test as partial proxy for socioeconomic status (AS, service-connected; AN, no service connected disability without paying copayment because of low income; NO, non-veteran; and XO, veterans not required to complete means test; with CO [required to pay copayment] as referent category), (7) service-connected disability rating (continuous variable), (8) taking insulin, (9) taking oral hypoglycemic agent, (10) body mass index (continuous variable), and (11) number of visits to primary care clinic during year from which outcome was taken (continuous variable). Bolded items identify the concept/issue captured by the variables.

physicians report only to the program (0.20%), being located at an acute care hospital (0.20%), and having a greater number of reported providers (0.020% per additional 10 provider full-time equivalents).

Combinations of Organization-level Characteristics

Compared with clinics having all characteristics at the baseline level, clinics that have the attributes just described that are directly related to the chronic care model and are associated with lower HbA_{1c} and have

other characteristics at the referent level would be expected to have patients with HbA_{1c} values that are lower by 1.87%. Clinics with all of the chronic care model elements related to lower HbA_{1c} and none of the characteristics associated with higher HbA_{1c} would be expected to have patients with HbA_{1c} values that are lower by 2.63%, compared with clinics with all attributes related to higher HbA_{1c} and none of the characteristics associated with lower HbA_{1c}.

In addition to considering the clinical significance of the organizational characteristics, the statistical signif-

ificance of including the block of characteristics that capture attributes of the chronic care model was assessed by calculating models with and without the characteristics. The -2 log likelihood values were compared. The findings indicated that the chronic care model attributes led to a better explanation of the variance in HbA_{1c}.

Sensitivity Analysis

To address the issue that many VA patients receive care within and outside the VHA system^{64,65} and at multiple VA facilities, we performed a sensitivity analysis in which the minimum number of visits to the individual's main VA clinic was varied. Although the results are not reported herein, the relationships among clinic features and HbA_{1c} generally did not differ from those presented in the article. Having teams only for specific clinical and administrative problems was no longer statistically significant at $P < .10$ when patients had to have had more than 2 visits during the year in which the outcome was recorded. The variable was significant at $P < .11$.

When including patients with 3 or more visits, the gatekeeping and specific team associations were not statistically significant. However, the point estimates were in the same direction as the reported results.

DISCUSSION

Although associations between HbA_{1c} and single organizational characteristics were not generally clinically significant, when taken together, the association between organizational factors and HbA_{1c} control among diabetic patients may have important clinical implications. The UK Prospective Diabetes Study results indicate that a reduction of 1% in HbA_{1c} leads to a 21% reduction in the risk of diabetes-related complications and deaths.³⁵ As already indicated, the combined effect of characteristics would be expected to be greater than 1%.

Although this study does not establish causal relationships, the findings point toward the following actions that, when taken together, may be associated with a clinically meaningful and beneficial difference in HbA_{1c}. Future research is needed to determine whether these associations reflect causal relationships and to ascertain what other factors predict their presence.

Characteristics Associated With Better Diabetes Control

Integrating Computerized Health Information Systems Into the Care of Persons With Chronic Illness. The finding that computerized diabetes reminders are

associated with better control of chronic disease is consistent with other studies.^{66,67}

Developing Multidisciplinary Clinical Teams and Other Specific Teams to Address Clinical Concerns. As hypothesized, both of these attributes were associated with lower HbA_{1c}.

Actively Involving Physicians in Quality Improvement Efforts. Lack of strong physician involvement in QI initiatives was associated with worse HbA_{1c} control. This may reflect that physicians provide most hands-on care in primary care settings, but it may also reflect the importance of having physicians model appropriate quality-of-care behaviors for other providers. The importance of physicians' modeling behavior has been noted in QI efforts such as programs to increase hand washing.⁶⁸

Monitoring the Potential Effect of Staff-reporting Relationships on Outcomes. Having nurses reporting only to the primary care program was associated with lower HbA_{1c}. However, the opposite was true for general internists. It can be hypothesized that the nurse association could happen because of greater involvement with the primary care team. The physician result is difficult to interpret because of the variety of relationships between physicians and VA facilities.

Giving Primary Care Programs Greater Authority to Implement Clinical Initiatives and Develop Staffing Arrangements. Although this study cannot indicate why greater authority over these areas was associated with lower HbA_{1c}, one hypothesis is that such clinics may be able to better organize into care teams and respond to clinical concerns.

Notifying Patients About Decisions Affecting the Delivery of Their Healthcare. Clinics reporting that they notify patients who their primary care provider is had patients with lower HbA_{1c}.

Although the association is of borderline statistical significance, greater use of gatekeeping within clinics was associated with lower HbA_{1c}. Because of the role of gatekeeping in attempting to reduce the use of specialty services, the word has developed a negative connotation among patients and providers.⁶⁹⁻⁷¹ If gatekeeping systems limit access to appropriate, timely care, one would hypothesize that it would be associated with worse outcomes. However, an ideal gatekeeping system would lead to providers and patients collaborating to identify and choose needed services.⁷⁰ Such coordination is in line with the chronic care model. It is therefore reasonable that the highest level of gatekeeping is associated with lower HbA_{1c} compared with the lowest use of the process.

Contrary to the hypothesis that continuity should lead to better chronic illness outcomes, clinics reporting that patients almost always see their assigned provider

are associated with higher HbA_{1c}. When considered along with a study⁷² indicating that part-time physicians of a large group-model health maintenance organization may provide slightly better diabetes care than full-time physicians, these results point to the need to further study the effect on diabetes control of systems that cause multiple primary care providers to be involved with an individual's management of the illness. A hypothesis proposed by Goldzweig et al⁷³ regarding similar results relating to breast and cervical cancer screening rates is that overly stringent assignment of providers may reduce access to other services needed to provide comprehensive care.

Limitations and Considerations

This study reports the relationship among broadly defined structural and delivery process characteristics and a specific intermediate diabetes outcome. The results do not prove a causal relationship between the attributes and better chronic illness management. However, findings indicate associations that provide additional evidence for the importance of a coordinated, team-based approach to primary care.

Because of the observational nature of this study, there is the potential that our findings are confounded by unmeasured characteristics. Variables included in this study capture important aspects of the chronic care model or were considered probable confounders based on known predictors of glycemic control. Our choice of hierarchical modeling and inclusion of known clinical predictors serve to reduce but not eliminate this concern.

The present study takes advantage of the opportunity to combine data from a clinical database (VA Diabetes Registry and Dataset) and VA administrative data. As in other studies using administrative data as opposed to data collected specifically for research studies, there is a reduced ability to measure some possible covariates, potential for missing or unknown data, and possibility that clinics may code diagnoses differently.^{74,75}

In our study, validity concerns are partially mitigated by the fact that laboratory values from the VA Diabetes Registry and Dataset⁷⁶ and diagnosis codes from the VA administrative databases⁷⁷⁻⁷⁹ have been shown to have high levels of validity. This combination of data sets allowed for the use of prescription and encounter criteria to determine patients eligible for inclusion in the study cohort. The result is increased internal validity because the cohort patients are more likely to actually have diabetes mellitus.

As with all surveys, the issues of social desirability (ie, wanting to appear supportive of VA initiatives) and

self-report may have affected the validity of the survey results. For example, having physicians and nurses involved in QI was a VA focus at the time of the survey. Therefore, some clinics may have overstated involvement in QI projects. Most organizational characteristics came from answers to the 1999 VHA Survey of Primary Care Practices. These were based on self-report and were not independently verified.

The VHA is different from most other healthcare delivery organizations. It resembles a staff-model health maintenance organization and promulgates a single diabetes practice guideline.^{80,81} Patients are mostly men who are sicker, older, and of lower socioeconomic status than the general population.^{13,34,82} Furthermore, the facilities in this study were larger than most VHA operations. Despite these differences, it is likely that many of the observed organizational effects are applicable in other practice settings.

Finally, data were not available on patients' primary care providers. Because of the variety of staffing arrangements in the VHA, we were unable to use administrative data to determine who actually cared for individual patients. However, evidence from the VHA indicates that, compared with facilities, providers account for a negligible percentage of the variance in HbA_{1c}.⁸³

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CONCLUSIONS

Our results suggest that programs simultaneously leading to integrated teams that actively involve physicians in QI, use electronic health information systems, provide programs with authority to respond to staffing and programmatic issues, and inform patients of important decisions have better glycemic control among their diabetic patients. These conclusions are based on clinics that face the variety of challenges encountered in the everyday practice of primary care.

Investigations designed to address the biopsychosocial needs of patients with chronic illnesses should also consider the environment into which interventions are placed. The present study indicates that decisions about how to structure the system in which care is provided may assist in improving clinical outcomes. Hence, the combination of data from managerial and clinical sources may be used to better inform the work of administrators and providers.

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