How Well Do Patients' Assessments of Their Diabetes Self-Management Correlate With Actual Glycemic Control and Receipt of Recommended Diabetes Services?

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OBJECTIVE — Although patient diabetes self-management is a key determinant of health outcomes, there is little evidence on whether patients' own assessments of their self-management correlates with glycemic control and key aspects of high-quality diabetes care. We explored these associations in a nationwide sample of Veterans' Affairs (VA) patients with diabetes.

RESEARCH DESIGN AND METHODS — We abstracted information on achieved level of glycemic control (HbA_{1c}) and diabetes processes of care (receipt of HbA_{1c} test, eye examination, and nephropathy screen) from medical records of 1,032 diabetic patients who received care from 21 VA facilities and had answered the Diabetes Quality Improvement Program survey in 2000. The survey included sociodemographic measures and a five-item scale assessing the patients' diabetes self-management (medication use, blood glucose monitoring, diet, exercise, and foot care [$\alpha = 0.68$]). Using multivariable regression, we examined the associations of patients' reported self-management with HbA_{1c} level and receipt of each diabetes process of care. We adjusted for diabetes severity and comorbidities, insulin use, age, ethnicity, income, education, use of VA services, and clustering at the facility level.

RESULTS — Higher patient evaluations of their diabetes self-management were significantly associated with lower HbA_{1c} levels ($P < 0.01$) and receipt of diabetes services. Those in the 95th percentile for self-management had a mean HbA_{1c} level of 7.3 (95% CI 6.4–8.3), whereas those in the 5th percentile had mean levels of 8.3 (7.4–9.2). For every 10-point increase in patients' ratings of their diabetes self-management, even after adjusting for number of outpatient visits, the odds of receiving an HbA_{1c} test in the past year increased by 15% (4–27%), of receiving an eye examination increased by 16% (7–27%), and of receiving a nephropathy screen increased by 13% (2–26%).

CONCLUSIONS — In this sample, patients' assessments of their diabetes self-care using a simple five-question instrument were significantly associated both with actual HbA_{1c} control and with receiving recommended diabetes services. These findings reinforce the usefulness of patient evaluations of their own self-management for understanding and improving glycemic control. The mechanisms by which those patients who are more actively engaged in their diabetes self-care are also more likely to receive necessary services warrant further study.

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Improving clinical outcomes in diabetes requires patients to undertake and sustain a complex array of self-care behaviors, including taking medications, monitoring blood glucose levels, following a diet, engaging in regular exercise, and caring for their feet. These and other skilled behaviors to promote health and prevent complications are often called "self-management." Randomized controlled trials of interventions to improve patients' diabetes self-management have led to better glycemic control (1). Moreover, some studies suggest that patients who are more actively involved in their diabetes self-care, independent of contact with health care providers, may be more likely to receive important diabetes processes of care, such as HbA_{1c} tests and dilated eye examinations (2–6).

How best to evaluate and support patients' diabetes self-management is a critically important question. A number of reliable and valid self-reported measures describing different facets of diabetes self-management through questionnaires and structured interviews have been developed in recent years (7,8). These measures are helpful tools to enable clinicians and researchers to evaluate those areas of self-management in which patients with diabetes may need additional support. However, most studies of adults with type 2 diabetes have not sought to confirm a significant association between patients' reports of their diabetes self-management and glycemic control (8).

Although many factors influence glycemic control (e.g., genetics, physiology, and the quality of medical care), good self-management is a critical pathway to

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Abbreviations: DQIP, Diabetes Quality Improvement Project; HEDIS, Health Plan Employer Data and Information Set; IRB, Institutional Review Board; VA, Veterans' Affairs.

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

success. As we develop and evaluate initiatives to improve patients' diabetes self-management, assessing self-management in a way that correlates with achieved glycemic control is an important clinical and methodological issue. For example, in a nationwide sample of 1,314 diabetic patients receiving diabetes care from 25 Veterans' Affairs (VA) facilities, we found that patients who gave their health care providers higher ratings for communication effectiveness and participatory decision-making styles also evaluated their own diabetes self-management over the past year more positively (9). The scale in this study focused on a key component of patients' diabetes self-management: their assessment of how well they had been able to adhere to recommended treatment protocols. It consisted of patients' ratings of how difficult it had been over the past year to manage their diabetes self-care according to treatment recommendations in the areas of medication, diet, exercise, blood glucose monitoring, and foot care, a measure that incorporates both self-efficacy and understanding of provider recommendations. In determining the clinical implications of better patient-reported self-management, it is important to know whether patients' evaluations of their own self-management, using this scale, in turn correlated with their HbA_{1c} levels at the time they were surveyed. In addition, it would be useful to more rigorously test the hypothesis, raised in prior research (2–6), that "activated" patients who are more able to follow treatment protocols may also be more likely to receive recommended health care services. Accordingly, in a subsample of patients from the above study, we examined whether assessments of their diabetes self-management in five areas correlated with their level of actual glycemic control and other aspects of high-quality diabetes care (an HbA_{1c} test, a dilated eye examination, and a nephropathy screen within the recommended time period).

RESEARCH DESIGN AND METHODS

Study population

The initial sample comprised 2,000 veterans receiving diabetes care at 1 of 25 VA medical centers located in four Veterans' Integrated Service Networks, representing three of the four census regions (9,10). Patients were identified using electronic pharmacy and laboratory information for fiscal years 1998 and 1999 from each participating VA facility and a national utilization database (11,12). Patients were eligible if they had two outpatient visits of any kind in fiscal year 1999 and were identified as having diabetes based on the following criteria: within the past 12 months they had *1*) at least one prescription for a glucose control medication or monitoring supplies; *2*) two or more outpatient visits with a diabetes-related ICD-9 code; or *3*) one hospitalization with a diabetes-related ICD-9 code (250.x, 357.2, 362.0, or 366.41). From among those eligible, we selected a random sample of 80 patients from each of the 25 facilities for inclusion in the study.

Approval for the study was obtained from the VA Ann Arbor Institutional Review Board (IRB) and from the IRBs at 21 facilities. The survey was administered in collaboration with the VA Office of Quality and Performance as part of a broad effort to improve the quality of diabetes care in the VA Administration.

Data collection

The self-management questions were part of a questionnaire created for the Diabetes Quality Improvement Project (DQIP) (10,13). DQIP developed a number of quality measures adopted by the National Committee for Quality Assurance for use in the Health Plan Employer Data and Information Set (HEDIS) (14,15) and a patient survey to assess issues of diabetes care quality. The survey contained ~150 items as described elsewhere (9). A total of 1,431 participants from 25 facilities returned a survey, for an overall response rate of 72%. Administrative data showed that the respondents were older (68 vs. 65 years, $P < 0.001$) and had more outpatient visits than nonrespondents in the study period (4.8 vs. 4.1, $P < 0.001$).

As described elsewhere (16), trained experienced medical abstractors used an electronic medical record abstraction tool to collect data necessary to calculate the diabetes set of measures used for the fourth quarter 2000 VA External Peer Review Program (http://www.oqp.med.va.gov; accessed 12 February 2002), which includes the DQIP and HEDIS 2000 diabetes set measures (15–17). The time period for data collection was 1 February 1999 to 31 January 2000 for most measures and 1 February 1998 to 31 January 2000 for the measures requiring 2 years of data.

We requested medical record information for the 1,174 survey respondents at the 21 facilities with IRBs (no chart reviews were conducted at four facilities without IRBs). Of these requested records, 89 (8%) were not abstracted because they could not be located ($n = 28$), because the record did not indicate a visit to the facility during the study period ($n = 44$), or because the record did not indicate that the patient had diabetes ($n = 17$). Of the remaining 1,085 cases, 53 were dropped before analyses because their surveys indicated that they were deceased ($n = 18$) or that they did not have diabetes ($n = 35$). This resulted in a final sample of 1,032.

Study variables

A scale for patients' assessment of their diabetes self-management was the principal independent variable for this study's analyses. For five separate areas of diabetes self-care (taking medications, exercising, following an eating plan, blood glucose monitoring, and foot care), respondents were asked, "Over the past year, how difficult has it been for you to do each of the following exactly as the doctor who takes care of your diabetes suggested?" Five of the valid response categories ranged from "So difficult that I couldn't do it at all" to "Not difficult, I got it exactly right." Respondents could also mark that that area of diabetes care was "Not applicable" for them. Possible scores for the scale ranged from 0 to 100, with higher scores meaning greater treatment adherence in the five domains (mean 71.3, SD 17.11, Cronbach's α 0.68). The scale was designed to reflect how well patients feel able to manage aspects of their diabetes care and has been found to be a valid reflection of self-care behaviors (13). In light of the evidence that adherence to treatment recommendations in one area of diabetes care may not correlate strongly with adherence in others (7,8,18,19), we also looked at each domain separately.

Other variables included in the analyses to adjust for factors that might influence glycemic control and receipt of diabetes services included patients' age, sex, ethnicity (coded as white and minority), education level, household income, insulin use (vs. oral medications only or no medications), and diabetes severity

and comorbidities. The number and severity of diabetes comorbidities were measured using the components of the Total Illness Burden Index directly related to diabetes, a validated scale that ranges from 0 to 100 (13,20,21). In addition, we adjusted for VA health services use with two measures: whether respondents had received >80% of their health care at that VA facility in the past year and whether they had had more than two outpatient visits at that facility in the past year.

Our principal dependent variables were patients' most recent recorded HbA_{1c} before survey administration (January 2000) and three DQIP process measures (receipt of an HbA_{1c} test and dilated eye examination in the study period [1 February 1999 to 31 January 31] and nephropathy screen in the study period or year before) constructed from medical record data. Each process measure was coded 1 if eligible patients had received the service within the recommended time interval. We also gathered information on whether patients had received foot examinations and blood pressure checks. Because almost all patients in our sample had received both of these (85 and 99%, respectively), we did not include them in our analyses.

Analyses

The data were analyzed using bivariate and multivariable methods with Stata 7 on datasets with all linkable identifying information removed (22). We used multiple linear regression to assess the relationship between patients' reported self-management and HbA_{1c} level and logistic regression to model the association between patients' self-management scores and receipt of necessary diabetes services. All regression models were adjusted for the covariates described above. The amount of missing data was <7% for all variables. However, to avoid selection bias and inaccurate inferences resulting from the cumulative effects of listwise deletion, we imputed values for three independent variables that had >5% missing data: patient education, income, and age (23). Because preliminary analyses suggested significant between-facility variation, we adjusted the standard errors using the Huber-White heteroskedastic consistent estimator of the variance/covariance matrix with cluster correction (24,25). Finally, because of the nonproportional sampling strategy, we estimated all regression models with sampling weights (26,27).

To demonstrate the magnitude of the association of self-reported self-management with patient HbA_{1c} values, we constructed a linear multivariate regression model to calculate predicted HbA_{1c} levels and rate of receipt of each diabetes service for the 5th percentile (score = 30), 50th percentile (score = 70), and 95th percentile (score = 100). We conducted similar analyses for receipt of key diabetes services using logistic regression. For these calculations, we held all covariate values constant at their means (21,28).

Regression diagnostic procedures yielded no evidence of substantive multicollinearity, heteroskedasticity, or overly influential outliers in any of the models. There was no evidence of significant interactions between diabetes self-management and ethnicity, income, diabetes severity, or education, or of second-order curvilinear relationships between the scale of self-reported self-management and any of the outcome variables.

RESULTS — Table 1 summarizes principal demographic and health characteristics of the survey sample. The overall health status of respondents was quite poor, with 60% describing their health as "poor" or "fair." Rates of health service use were high, with 92% having had more than two outpatient visits at their VA health facilities in the past year. Most (82%) patients received >80% of their care in the past year at their VA health facilities.

Relationship of patients' assessments of their diabetes self-management to glycemic control

Higher patient self-ratings of diabetes self-management were significantly associated with lower HbA_{1c} levels in bivariate analyses, and this finding persisted after adjusting for possible confounding variables. Patients' diabetes self-management (standardized $\beta = -0.13$, $P < 0.001$) and patients' age (standardized $\beta = -0.15$, $P < 0.001$) were both independently associated with lower HbA_{1c} levels, whereas being on insulin (standardized $\beta = 0.22$, $P < 0.001$) was associated with higher HbA_{1c} levels. No other covariates were significantly associated with HbA_{1c} levels in the multivariate model. In analyses looking separately at each of the five domains of the self-management scale, patients' positive assessments of the four domains of taking medications, monitoring blood glucose levels, diet, and exercise were each independently ($P < 0.05$) associated with lower HbA_{1c} levels. There was no significant association between patients' assessment of their foot self-care and their HbA_{1c} levels.

Predicted HbA_{1c} levels based on patients' ratings of their diabetes self-management are presented in Table 2. The 1-point difference in HbA_{1c} levels between patients with self-management scores in the 5th percentile and patients with scores in the 95th percentile is both statistically and clinically significant.

Table 1—*Characteristics of patient respondents*

Age (years)	67 ± 10
Years with diabetes	12 ± 10
Male sex	98
Ethnicity	
White	84
Minority	16
Years of education	12 ± 3
Income	
$10,000 or less	20
$10,001 to $15,000	26
$15,001 to $25,000	29
$25,001 or more	25
Hypoglycemic regimen	
Oral medications only	59
On insulin	34
No medications	7
Health status	
Excellent or very good	7
Good	33
Fair	43
Poor	17
Diabetes Comorbidity (TIBI) scale*	41 ± 19
Percent with >80% of care at VA facility	82
Percent with greater than two outpatient visits at VA in past year	92

Data are means ± SD or %. n = 1,032. *TIBI, Total Illness Burden Index (scaled from 0 to 100, with higher scores meaning more diabetes comorbidities).

Table 2—*Predicted mean HbA_{1c} level and percentage of patients who received diabetes services based on percentile of patients' diabetes self-management assessment scores*

	Predicted mean HbA_{1c} level	Percentage who received HbA_{1c} test	Percentage who received eye examination	Percentage who received nephropathy screen
Percentile of patients' diabetes self-management score				
5th (score = 30)	8.3 (7.4–9.2)	77 (55–98)	46 (34–88)	37 (22–52)
50th (score = 70)	7.7 (6.9–8.6)	85 (67–103)	60 (36–84)	55 (39–71)
95th (score = 100)	7.3 (6.4–8.2)	89 (75–103)	69 (47–91)	67 (51–83)

Data in parentheses are 95% CIs. Mean HbA_{1c} levels and mean percentages of patients who received each diabetes service were calculated for alternate values of patients' assessments of their diabetes self-management while holding all other variables constant at the mean, using the linear or logistic regression model with all covariates. All models were adjusted for ethnicity, sex, income, education, age, diabetes comorbidities, insulin use, whether the patient had two or more outpatient visits at the VA facility in the past year, whether the patient received >80% of care at the VA facility in the past year, sampling weights, and clustering at the facility level.

Relationship of patients' assessments of their diabetes self-management to receipt of necessary diabetes services

A more positive self-management assessment was also associated with having received an HbA_{1c} test, an eye examination, and a nephropathy screen within DQIP- and HEDIS-recommended time intervals. Even after adjusting for other possible confounders, including two measures of health services use, for every 10-point increase in self-rated diabetes management, the odds of having received an HbA_{1c} lab increased by 15%, receipt of an eye examination by 16%, and receipt of a nephropathy screen by 18% ($P < 0.005$ for all three services). Table 2 shows the increases in mean percentages of patients who received all three of the recommended diabetes services with increases in their diabetes self-management assessment scores.

CONCLUSIONS — In this study, patients' assessments of their diabetes self-management were significantly associated with their achieved glycemic control, even after controlling for possible confounding variables. The separate domains of taking medications, monitoring blood glucose levels, exercising regularly, and following a diabetes diet were each independently associated with glycemic control. In light of the complex set of factors that contribute to glycemic control, it is not surprising that our multivariable model accounted for only 11% of the variance in HbA_{1c} values. Patient behaviors alone do not determine glycemic control. However, the magnitude of the correlation between the self-management scale and HbA_{1c} levels was clinically significant. The difference in HbA_{1c} between someone at the low versus the high end of the self-management scale was 1 full point. Moreover, we found that patients' reported self-management was associated with receiving all three diabetes care processes that we examined.

Our findings suggest that patients' evaluations of their diabetes self-management with this scale may indeed serve as a proxy for self-care behaviors that lead to improved glycemic control. These results also reinforce other researchers' findings of the importance of assessing patients' self-management, so as to better understand obstacles patients may face and to evaluate how educational or other care strategies may improve glycemic control (7). Finally, our findings raise intriguing questions about why patients with better self-reported diabetes management also were more likely to have received necessary diabetes processes of care. It is possible that those providers with communication and decision-making styles more supportive of patients' diabetes self-management also are more likely to order and ensure that their patients receive necessary services (9,29,30). However, the converse may also be true: patients who are more effective in following recommended self-care protocols (and have greater confidence in their abilities as reflected in their self-assessment) may also be more effective in securing necessary diabetes services (4, 29,31). For example, these patients may be more informed about the tests they need and remind their providers when certain tests are due, or they may be more likely to follow through on getting the tests and services (e.g., dilated eye examinations) their providers order. Further research, using longitudinal design and controlling for provider effects, should explore whether and how those patients who are more actively engaged in their diabetes self-care are also more likely to receive necessary services.

Our study has a number of limitations. First and most importantly, its cross-sectional design does not allow us to establish that patients' assessment of their diabetes self-management was causally associated with glycemic control or receipt of diabetes services. Patients with better glycemic control may evaluate their self-management as better than those who have more serious disease and higher HbA_{1c} levels, and those patients who receive more recommended services may also have better reported self-management for another reason not measured in our analyses. Regarding this point, it is worth noting that patients' reported self-management was not associated with either of our two measures of health services use. This lack of association suggests that fewer outpatient visits is not the reason patients who evaluate their self-management poorly are less likely to receive necessary tests. Second, this study population consisted predominantly of older men. Our findings may not be generalizable to younger or predominantly female populations and should be repeated in other settings. Third, it is important to emphasize that the measure we used provides both a general assessment of how difficult patients found carrying

out recommended activities in five areas of diabetes self-care and their evaluation of their level of success in undertaking these activities. In this sense, it is complementary to other self-management measures that explicitly enable patients to describe or quantify their self-care activities within a discrete recent time interval (7). These other measures may be more useful in targeting specific ways to help patients improve their current self-management. With the exception of a recent measure developed for type 1 diabetes that correlated with HbA_{1c} levels in a sample of adolescents (8), these scales have not been shown to correlate with glycemic control. One could argue that the measure we assessed in this study serves as a marker for confidence in performance of past diabetes self-care activities. Moreover, because this scale assesses how closely patients executed treatment recommendations in five areas of diabetes self-care, it may also be tapping into how well patients understand these recommendations and whether their providers have in fact provided clear guidance in each area. Future research should explore how the scale we used in this study correlates with self-reported measures that provide more precise descriptions of the frequency with which respondents performed various self-care activities and with scales explicitly assessing patients' "self-efficacy" (7,8,32,33). It would also be useful to evaluate the utility of this scale in measuring the impact of outpatient education programs and other interventions on patients' assessments of their diabetes self-management.

In conclusion, we found that patients' evaluation of their diabetes self-management was associated with both their HbA_{1c} levels and their receipt of recommended diabetes services. A scale that correlates with glucose control can be used in two important ways: *1*) to assess glucose control in settings, such as survey research and community programs, in which HbA_{1c} values are not readily available and 2) in clinical settings to help elucidate which aspects of self-care patients may be having trouble with and thus better target educational and motivational efforts. The association of patients' reported self-management and receipt of diabetes services is consistent with current hypotheses that "more activated" patients may interact with their providers in a way to help ensure that they receive necessary technical processes of care (4,6,34).

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