The Relationship Between Knowledge of Recent HbA_{1c} Values and Diabetes Care Understanding and Self-Management

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OBJECTIVE — Knowledge of one's actual and target health outcomes (such as HbA_{1c} values) is hypothesized to be a prerequisite for effective patient involvement in managing chronic diseases such as diabetes. We examined *1*) the frequency and correlates of knowing one's most recent HbA_{1c} test result and *2*) whether knowing one's HbA_{1c} value is associated with a more accurate assessment of diabetes control and better diabetes self-care understanding, self-efficacy, and behaviors related to glycemic control.

RESEARCH DESIGN AND METHODS — We conducted a cross-sectional survey of a sample of 686 U.S. adults with type 2 diabetes in five health systems who had HbA_{1c} checked in the previous 6 months. Independent variables included patient characteristics, health care provider communication, and health system type. We examined bivariate and multivariate associations between each variable and the respondents' knowledge of their last HbA_{1c} values and assessed whether knowledge of HbA_{1c} was associated with key diabetes care attitudes and behaviors.

RESULTS — Of the respondents, 66% reported that they did not know their last HbA_{1c} value and only 25% accurately reported that value. In multivariate analyses, more years of formal education and high evaluations of provider thoroughness of communication were independently associated with HbA_{1c} knowledge. Respondents who knew their last HbA_{1c} value had higher odds of accurately assessing their diabetes control (adjusted odds ratio 1.59, 95% CI 1.05–2.42) and better reported understanding of their diabetes care ($P < 0.001$). HbA_{1c} knowledge was not associated with respondents' diabetes care self-efficacy or reported self-management behaviors.

CONCLUSIONS — Respondents who knew their HbA_{1c} values reported better diabetes care understanding and assessment of their glycemic control than those who did not. Knowledge of one's HbA_{1c} level alone, however, was not sufficient to translate increased understanding of diabetes care into the increased confidence and motivation necessary to improve patients' diabetes self-management. Strategies to provide information to patients must be combined with other behavioral strategies to motivate and help patients effectively manage their diabetes.

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Abbreviations: AMC, academic medical center; PCP, primary care provider; VA, Veterans Affairs.

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

A growing body of evidence suggests that patients with chronic diseases who are engaged and active participants in their health care have better health outcomes (1–4). For example, patients who have completed chronic disease self-management training programs have improved self-efficacy and physical functioning and less acute care use than nonparticipants (2,5–8). Chronic illness care self-efficacy is positively associated with health outcomes (9–15). Similarly, collaborating with health care providers and engaging in shared clinical decision making are associated with better self-care behaviors and disease outcomes (1,6,14,16–20).

Less is known, however, about the specific skills, knowledge, beliefs, and motivations that patients need to most effectively participate in their chronic disease management. Patient knowledge of actual and target disease management outcomes (e.g., HbA_{1c} test results) is hypothesized to be an important prerequisite for effective patient "activation." Providing immediate feedback of HbA_{1c} values to insulin-taking diabetic adults and their providers (21) and graphical information to patients on their HbA_{1c} and other laboratory values has been found to improve glycemic control and other diabetes outcomes (22). Organizations such as the American Diabetes Association have launched campaigns urging diabetic patients to be aware of their target and actual HbA_{1c} values, blood pressure, and cholesterol levels (their "ABCs") and to be proactive in discussing these with their doctors (23).

Prior studies have documented that many diabetic patients do not know whether they had a recent HbA_{1c} test or its value (24–26). There is little empirical information, however, on factors that influence whether patients know their last HbA_{1c} values and have an accurate assessment of what that value means. It also is unclear whether knowing one's level is indeed associated with better patient self-management, self-efficacy, or other

positive health outcomes. Moreover, although differences in patient activation may contribute to racial/ethnic disparities in diabetes processes and outcomes of care (27), few studies have explicitly tested this hypothesis. Therefore, we examined *1*) the prevalence and correlates of knowing one's most recent HbA_{1c} value; *2*) whether knowing one's HbA_{1c} is associated with a more accurate assessment of one's level of diabetes control, better understanding of diabetes care, diabetes care self-efficacy (i.e., the confidence that one can carry out a behavior necessary to reach a desired goal) and self-management behaviors; and *3*) racial/ethnic differences in accurately knowing one's HbA_{1c} level and in other measures of diabetes self-care and outcomes.

RESEARCH DESIGN AND METHODS

— The study sample was drawn from 843 adults with type 2 diabetes receiving care in southeast Michigan health care facilities who had been surveyed about their diabetes-related knowledge, attitudes, and service use. Participants were surveyed between May 2001 and October 2002 in a Veterans Affairs (VA) medical center, an academic medical center (AMC), and three inner-city health systems (a total of five sites). The survey protocols received institutional review board approval at all sites, and written informed consent was obtained from all participants. Eligible patients in the VA and AMC samples, identified through electronic medical records, were ≥30 years old, had a prescription for a glucose control medication or supplies or one hospitalization or two outpatient visits with a diabetes-related ICD-9 code, had seen their primary care provider (PCP) in the prior 6 months, and were scheduled to see the same PCP again in the next 6 months.

In all, 562 eligible VA patients and 720 eligible AMC patients were identified and sent surveys by mail. Excluded were 74 patients who reported not having type 2 diabetes, had severe dementia, or were deceased. Of the remaining patients, 663 completed the survey (56% response rate). Participants identified at inner-city health systems from electronic medical records were recruited as part of the "Racial and Ethnic Approaches to Community Health 2010" Detroit Partnership, supported by the Centers for Disease Control and Prevention and described elsewhere (28). Participants had type 2 diabetes and were ≥18 years old, lived in selected zip codes, and received diabetes care for at least 1 year from their PCPs. Patients were excluded if they had a terminal illness that would preclude participation in a self-management intervention. In all, 346 eligible inner-city patients were identified, of which 180 agreed to enroll and completed the baseline survey upon which this study's analyses are based (52% response rate). In total, 1,554 eligible patients were identified and 843 completed baseline surveys (55% response rate). Respondents at the VA and AMC were more likely to be older, married, nonwhite, and male than nonrespondents. Respondents in the inner-city health systems were more likely to be older and female than nonrespondents.

For the current study, we identified respondents who had recorded HbA_{1c} values within the 6-month period before taking the survey (81% of all survey respondents). Patients who were nonwhite, using no medications, and receiving care at the inner-city health systems were less likely to have recorded HbA_{1c} values.

All participants completed surveys that included core questions about their characteristics, diabetes self-management, and quality of diabetes care. The AMC/VA patient survey was a self-administered written English survey and the inner-city survey was conducted in-person in either Spanish or English.

In the survey, respondents were asked, "What has your HbA_{1c} (lab value for overall sugar control) been in the past 6 months?" Respondents could choose one of six response categories: <7; between 7 and 8; between 8 and 9; between 9 and 10; >10; and don't know. We classified respondents as knowing their HbA_{1c} value if their actual test result was within 0.5 percentage points of the lower or upper boundary of the chosen response category. For example, if respondents reported that their HbA_{1c} was <7, they were grouped as knowing their HbA_{1c} if their recorded HbA_{1c} was <7.5. Respondents were coded as not knowing their value if their estimate differed by >0.5% or if they responded, "I don't know."

To assess whether respondents had a biomedically accurate assessment of their HbA_{1c} value, we created a variable comparing the self-evaluation of the level of diabetes control in the past 6 months with the actual HbA_{1c} test value. On the survey, respondents were asked whether, based on their HbA_{1c} value in the past 6 months, their diabetes was in "excellent," "good," "fair," or "poor" control. We classified respondents as having an accurate assessment of their HbA_{1c} value if they evaluated their diabetes control as poor and had HbA_{1c} values >8.5; reported "fair" and had HbA_{1c} between 7.5 and 8.5; or reported "good" or "excellent" and had HbA_{1c} ≤7.5.

To evaluate self-rated understanding of diabetes care, we used the following question from the Diabetes Care Profile: "How well do you understand how to manage your diabetes?" (29,30) Higher values of this measure rated on a 1–5 Likert scale reflected higher levels of self-reported understanding. To assess diabetes care self-efficacy, we used a validated four-item scale (15), with higher scores reflecting higher self-efficacy in managing diabetes. This measure has been associated with glycemic control in prospective studies (15,31). To assess self-care behaviors related to glycemic control, we used respondents' answers to a validated measure asking on how many of the past 7 days (days 0–7) they performed the following as their doctor had recommended: take diabetes medications, follow a diabetic eating plan, and monitor blood glucose (32,33). Because adherence in one area of diabetes care does not correlate strongly with adherence in others (32,34), we examined each behavior separately.

We reviewed medical records and laboratory data to document respondents' most recent HbA_{1c} results taken within 6 months before the survey. If respondents had no documented HbA_{1c} results in the prior 6 months, we recorded this value as missing.

We included the following patient characteristics in all the multivariate models: age, sex, annual household income (≤$10,000, $10,001–30,000, >$30,000), education (<high school, high school, at least some college), race/ethnicity (non-Latino white, African American, Latino, Asian, Native American, or Middle Eastern), diabetes duration (≤3 or ≥4 years), and hypoglycemic medications they were currently taking (no medications, oral medication only, or insulin ± oral medications). To evaluate thoroughness of provider communication, we assessed the degree to which re-

spondents agreed with the following statement from the well-validated Autonomy Support Scale: "My doctor answers my questions fully and carefully" (with five response categories from "strongly disagree" to "strongly agree") (15,16). Because responses were positively skewed toward the highest rating, we dichotomized responses between those who "strongly agreed" with the statement versus all other responses. We also included variables for health care site (VA, AMC, or inner-city health system), mean number of outpatient visits in the prior year (continuous), and duration of the relationship with the doctor who takes care of the patient's diabetes (<6 months, 6 months to 1 year, 1–5 years, >5 years).

We conducted bivariate and multivariate logistic regression analyses to explore patient, provider, and health care system characteristics associated with knowing one's most recent HbA$_{1c}$ value. We then used multivariate linear and logistic regression to assess whether knowledge of one's last HbA$_{1c}$ was associated with an accurate assessment of one's level of diabetes control, diabetes care understanding, self-efficacy, and self-management behaviors related to glycemic control. To determine the sensitivity of our findings to the specific cutoff points we used in our constructed variables for knowledge of HbA$_{1c}$ and assessment of diabetes control, we conducted additional analyses using different cutoff points for these variables. These alternative cutoff points did not significantly change the findings. We also conducted analyses separately for patients who reported some value for their last HbA$_{1c}$ versus those who reported that they did not know their last HbA$_{1c}$ value. In these analyses, many of the statistical associations remained significant and the magnitude of effect estimates was similar. Finally, because of the differences in survey methodology and clustering of ethnic groups in different health systems, we conducted all the analyses separately for the AMC/VA sites and the inner-city health sites. Regression diagnostic procedures yielded no evidence of multicolinearity or overly influential outliers in any of the models.

RESULTS — Overall, the sample was socioeconomically and ethnically diverse (Table 1) with 69% non-Latino white, 17% African American, and 8% Latino (primarily Mexican American). For education, 55% had a high school education or less; 71% had annual household incomes of $30,000 or less. In all, 94% were receiving oral medications or insulin ± oral medications. The mean number of outpatient visits in the past year was 4.1 ± 3.0. In total, 38% of respondents received care at the VA, 44% at the AMC, and 18% at the inner-city health systems.

Characteristics of the patients by race/ethnicity are presented in Table 1. A higher percentage of African-American and Latino respondents had incomes <$30,000 than the other two groups and a much higher percentage of Latino respondents had not completed high school. African-American and Latino respondents predominantly received care at the inner-city health systems, with more outpatient visits in the past year and higher rates of insulin use on average. African-American and Latino respondents on average had higher recorded HbA$_{1c}$ values than the other two ethnic groups, with Latino respondents having the highest HbA$_{1c}$ values (8.5 ± 2.3). There were no significant differences among ethnic groups in assessments of their diabetes control, diabetes care self-efficacy, or evaluations of providers' communication. Latino respondents had lower self-reported understanding of their diabetes care and reported following a diabetes eating plan fewer days in the prior 7 days than the other groups. There were no ethnic differences in reported medication taking and blood glucose monitoring over the prior 7 days.

Overall, 66% of respondents reported that they did not know their last HbA$_{1c}$ value, and 25% of respondents accurately reported their most recent HbA$_{1c}$ value. The majority of those who reported an HbA$_{1c}$ value were relatively accurate (Table 2). A higher percentage of those who reported lower HbA$_{1c}$ values were accurate compared with patients who reported higher HbA$_{1c}$ levels. For example, 76% of the 67 respondents who reported that their last HbA$_{1c}$ was <7 had documented HbA$_{1c}$ values in that range, whereas 40% of the 25 respondents who reported that their last HbA$_{1c}$ was >10 had documented HbA$_{1c}$ values >10.

Table 3 shows the bivariate and adjusted odds of accurately knowing one's most recent HbA$_{1c}$ values. In the bivariate analyses, significantly lower percentages of Latinos (8%) accurately reported their last HbA$_{1c}$ than respondents of other ethnicities. Lower percentages of respondents with less than a high school education, income ≤$10,000, and who received care at the VA or inner-city health systems knew their HbA$_{1c}$ values than other groups (Table 3). Moreover, 30% of those who strongly agreed that their diabetes doctor fully answered their questions knew their HbA$_{1c}$, compared with 21% of those who did not strongly agree ($P < 0.01$).

In multivariate logistic regression models (Table 3), years of formal education and high evaluations of thoroughness of provider communication were associated with knowledge of recent HbA$_{1c}$ values. Receiving care at the VA was associated with lower odds of knowing one's recent HbA$_{1c}$ value. In additional analyses that included language preference (Spanish vs. English), there was no association with knowledge of HbA$_{1c}$. In the separate multivariate analyses for the AMC/VA populations and inner-city populations, we found the same pattern of associations in the two groups, except that higher income remained significantly associated with HbA$_{1c}$ knowledge in the AMC/VA subsample.

In multivariate analyses, respondents who knew their last HbA$_{1c}$ value had higher odds of reporting a biomedically accurate level of diabetes control (odds ratio 1.59; 95% CI 1.05–2.42). In all, 56% of respondents who knew their HbA$_{1c}$ gave accurate assessments of their diabetes control compared with 45% of those who did not know their HbA$_{1c}$ ($P < 0.001$). Similarly, knowing one's HbA$_{1c}$ was associated with higher scores on the measure of patients' reported diabetes care understanding (β 0.17, $P < 0.001$). Those who knew their HbA$_{1c}$ had mean diabetes understanding scores of 3.80 ± 0.89 compared with mean scores of 3.38 ± 0.93 among those who did not know their last HbA$_{1c}$ value ($P < 0.001$). However, knowledge of HbA$_{1c}$ was not associated with better diabetes care self-efficacy or any of the three specific diabetes self-care domains that we assessed (β coefficients −0.032 to −0.006; *P* values 0.50–0.90). This same pattern of associations was also found when we analyzed the AMC/VA and inner-city subsamples separately.

CONCLUSIONS — Regular testing of HbA$_{1c}$ values is now the principal way

Table 1—*Characteristics of study participants by race* (N = 686)

	White (%)	Black (%)	Latino (%)	Other (%)	*P* value
n	448	122	70	46	
Age (years)					0.02
22–55	25	42	25	39	
55–70	39	35	75	37	
>71	36	22	0	24	
Male	76	38	33	67	<0.001
Education					<0.001
Less than high school	22	21	70	25	
High school	31	29	12	15	
Some college	47	49	18	60	
Annual income					<0.001
<$10,000	16	20	47	10	
$10,001–30,000	51	64	44	36	
>$30,000	33	9	9	54	
Length of diabetes					0.05
≤3 years	29	21	25	36	
≥4 years	71	79	75	64	
Hypoglycemic regimen					0.067
Oral medications only	70	57	57	70	
Insulin ± oral medication	23	36	37	28	
No medication	7	6	6	2	
Outpatient visits in past year	3.4 ± 2.3	5.6 ± 3.3	7.4 ± 4.4	3.3 ± 2.4	<0.001
Last HbA_{1c} checked (%)	7.3 ± 1.4	7.8 ± 2.2	8.5 ± 2.3	7.0 ± 1.2	<0.001
Health system					
VA	52	23	7	64	<0.001
AMC	48	13	7	26	
Inner-city	0	64	86	10	
Strongly agreed that diabetes doctor answers questions fully	30%	36%	37%	30%	0.49
Had biomedically accurate assessment of diabetes control	48%	52%	50%	57%	0.64
Self-reported understanding of diabetes self-care*	3.54 ± 0.91	3.69 ± 0.91	3.20 ± 0.96	3.64 ± 0.98	<0.001
Diabetes care self-efficacy*	70.6 ± 18.7	75.8 ± 17.9	71.5 ± 15.7	70.6 ± 20.6	0.06

Data are frequencies (or percent) or means ± SD for respondents with available HbA_{1c} data. Because of rounding, percentages may not equal 100. *Range of understanding scale was 1–5 and range of self-efficacy scale was 0–100; for both, higher scores are better.

to measure and track glycemic control in diabetes. Because of its importance as a marker of disease control, it makes sense that patient knowledge of recent and target HbA_{1c} values might be a useful precondition for involvement in diabetes management. Accordingly, in recent years there has been an increased focus on encouraging patients to be aware of and discuss these values with their clinicians (21–23).

Few respondents in our study, however, knew their most recent HbA_{1c} value. These low rates are similar to those of earlier studies (24–26). For example, in a 2002 study, 24% of those who reported having an HbA_{1c} test in the past year reported an actual test value, and those self-reported values correlated poorly with the medical record HbA_{1c} (26). The correlates of HbA_{1c} knowledge in our study corresponded to factors associated with key aspects of diabetes care understanding and self-care in prior studies (34–37). Although Latino respondents were less than half as likely to know their last HbA_{1c} than patients of other ethnicities, this was largely explained by their lower educational levels. In multivariate models, more years of formal education was the only sociodemographic characteristic associated with higher odds of knowing one's recent HbA_{1c} values. The independent association between a high evaluation of provider thoroughness of communication with HbA_{1c} knowledge is consistent with research on the importance of effective provider communication for improved patient understanding and chronic disease self-care (38–42). Further research should elucidate why VA respondents had significantly lower odds than patients at the other sites of knowing their last HbA_{1c}.

In bivariate and multivariate analyses, knowing one's last HbA_{1c} was associated both with accurately assessing one's level of diabetes control and with reporting better diabetes care understanding. Respondents who accurately reported their HbA_{1c} values had 60% higher odds of correctly assessing their level of biomedical control of their diabetes than those who did not. These findings reinforce the

Table 2—*Comparison of respondents' reported HbA$_{1c}$ with their most recent documented HbA$_{1c}$*

Reported HbA$_{1c}$ (%)	Actual HbA$_{1c}$ (%)				
	<7	7–8	8–9	9–10	>10
<7	51	13	1	1	1
7–8	33	30	7	3	3
8–9	11	11	12	6	1
9–10	4	6	7	3	0
>10	2	3	6	4	10
Don't know	186	115	64	44	48

Data are *n*.

importance of sharing with patients clear and specific information on their disease status and markers, such as HbA$_{1c}$, blood pressure, and lipid values (43). An estimated 50–80% of adults with diabetes have significant diabetes-specific knowledge and skill deficits (7,26,44). Potentially effective strategies to complement verbal communication to patients on actual and target disease values include providing clear graphical representations of these values (21,22,45) and encouraging patients to record and track laboratory and other measurements in diabetes logbooks or "passports" (46–48). Such strategies may be especially important to convey clinical information to patients with low health literacy and little formal education (49,50).

Knowledge of recent HbA$_{1c}$ test findings was *not* associated with either diabetes care self-efficacy or with better short-term self-management practices related to glycemic control. These findings reinforce that factors beyond knowledge of disease-specific information are necessary to heighten patients' self-confidence in their diabetes management and to improve diabetes self-management. A growing number of studies suggest that addressing patients' own perceptions of barriers to self-care and tapping into patients' values, motivations, and goals are more effective in improving metabolic control than seeking exclusively to increase knowledge about diabetes care (6,7,34,51–54). Greater patient knowledge alone does not correlate with improved glycemic control, and simply providing information more clearly is not enough to motivate patients. To enhance patients' diabetes care self-efficacy and self-management, providers need to promote patients' capacity to define the problems they are facing, make informed decisions about their diabetes management, and set realistic goals and strategies to meet those goals (16,17,22).

Although our study's findings are consistent with prior work in this area, the study has limitations. First, we can only show associations, not causality, in this cross-sectional study. Second, these analyses only included respondents for whom we had recorded HbA$_{1c}$ values and who had received regular medical care in the prior year. Third, patients only were asked whether they knew their actual HbA$_{1c}$ values, not whether they knew what their target level should be. Knowledge of both actual and target values may be important for enabling patients to monitor their progress toward achieving diabetes control. In addition, the multiple-choice format of the HbA$_{1c}$ may have cued some respondents to what their HbA$_{1c}$ value was. Fourth, the response rate was relatively low (55%). Those most intrinsically interested in the subject matter or with some other motivation (e.g., possibly increased need) may have been disproportionately likely to participate, reducing the generalizability of our findings. Finally, we did not have uniform eligibility criteria and selection processes for all respondents, and survey administration differed between the inner-city and other populations (in-person vs. written). Moreover, because the ethnic groups were largely clustered in different health systems, even though health site was included as a variable in all of the models, we could not adequately adjust for health site differences.

Table 3—*Bivariate and adjusted odds of accurately knowing one's most recent HbA$_{1c}$ value*

	%	Odds ratios (95% CI)	
		Unadjusted	Adjusted for other patient characteristics
Race			
White	27	Referent	Referent
Black	19	0.65 (0.37–1.11)	0.51 (0.22–1.18)
Latino	8	0.23 (0.18–0.65)	0.51 (0.14–1.48)
Other	37	1.65 (0.84–3.25)	1.21 (0.55–2.67)
Education			
Less than high school	7	Referent	Referent
High school	22	3.49 (1.74–6.99)	2.37 (1.09–5.15)
Some college	36	6.91 (3.65–13.1)	3.72 (1.78–7.78)
Annual income			
<$10,000	13	Referent	Referent
$10,001–30,000	20	1.62 (0.90–2.90)	1.11 (0.55–2.23)
>$30,000	40	4.39 (2.43–8.02)	1.81 (0.86–3.82)
Diabetes duration			
≤3 years	25	Referent	Referent
≥4 years	26	1.10 (0.61–1.52)	1.32 (0.78–2.29)
Medications			
Oral only	26	Referent	Referent
Insulin ± oral	21	0.75 (0.48–1.14)	0.87 (0.50–1.51)
No medications	30	1.22 (0.60–2.49)	0.82 (0.34–2.01)
Health system			
AMC	36	Referent	Referent
VA	16	0.35 (0.23–0.53)	0.55 (0.33–0.92)
Inner-city	14	0.29 (0.16–0.52)	0.70 (0.26–1.89)
Whether diabetes doctor answers questions fully			
Did not strongly agree	21	Referent	Referent
Strongly agree	30	1.55 (1.05–2.29)	1.60 (1.03–2.48)

The multivariable logistic models included all the variables listed in the table and also adjusted for patients' age, sex, number of outpatient visits, and having a regular doctor, none of which were associated with knowing one's most recent HbA$_{1c}$. Accurately knowing one's last HbA$_{1c}$ was defined as accurately reporting (within a ±0.5 range) one's last HbA$_{1c}$ value.

In conclusion, a minority of diabetic patients in our study knew their most recent HbA_{1c} value. Respondents who knew their HbA_{1c} values reported significantly better diabetes care understanding and assessment of their biomedical level of glycemic control than those who did not. These findings support the importance of providers actively discussing HbA_{1c} test results with patients and ensuring that patients understand the meaning of their HbA_{1c} level. Knowledge of HbA_{1c} alone, however, was not associated with better diabetes care self-efficacy and self-management behaviors. As with other areas of diabetes knowledge, knowledge of one's last HbA_{1c} value appears to be useful but not sufficient for translating increased understanding of diabetes care into the increased confidence and motivation necessary to improve patients' diabetes self-management. Strategies to provide information must be combined with other behavioral strategies to motivate and help patients effectively manage their diabetes.

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