

Physician Performance and Racial Disparities in Diabetes Mellitus Care

Thomas D. Sequist, MD, MPH; Garrett M. Fitzmaurice, ScD; Richard Marshall, MD; Shimon Shaykevich, MS; Dana Gelb Safran, ScD; John Z. Ayanian, MD, MPP

Background: Little information is available regarding variations in diabetes mellitus (DM) outcomes by race at the level of individual physicians.

Methods: We identified 90 primary physicians caring for at least 5 white and 5 black adults with DM across 13 ambulatory sites and calculated rates of ideal control of hemoglobin A_{1c} (HbA_{1c}) (<7.0%), low-density lipoprotein cholesterol (LDL-C) (<100 mg/dL), and blood pressure (<130/80 mm Hg). We fitted hierarchical linear regression models to measure the contributions to racial disparities of patient sociodemographic factors, comorbidities, and physician effects. Physician effects modeled the extent to which black patients achieved lower control rates than white patients within the same physician's panel ("within-physician" effect) vs the extent to which black patients were more likely than white patients to receive care from physicians achieving lower overall control rates ("between-physician" effect).

Results: White patients (N=4556) were significantly more likely than black patients (N=2258) to achieve control of HbA_{1c} (47% vs 39%), LDL-C (57% vs 45%), and blood pressure (30% vs 24%; $P < .001$ for all comparisons). Patient sociodemographic factors explained 13% to 38% of the racial differences in these measures, whereas within-physician effects accounted for 66% to 75% of the differences. Physician-level variation in disparities was not associated with either individual physicians' overall performance or their number of black patients with DM.

Conclusions: Racial differences in DM outcomes are primarily related to patients' characteristics and within-physician effects, wherein individual physicians achieve less favorable outcomes among their black patients than their white patients. Efforts to eliminate these disparities, including race-stratified performance reports and programs to enhance care for minority patients, should be addressed to all physicians.

Arch Intern Med. 2008;168(11):1145-1151

Author Affiliations: Division of General Medicine and Primary Care, Brigham and Women's Hospital (Drs Sequist, Fitzmaurice, and Ayanian and Mr Shaykevich), Department of Health Care Policy, Harvard Medical School (Drs Sequist and Ayanian), Harvard Vanguard Medical Associates (Drs Sequist and Marshall), The Health Institute, Institute for Clinical Research and Health Policy Studies, Tufts–New England Medical Center (Dr Safran), and Blue Cross Blue Shield of Massachusetts (Dr Safran), Boston.

RACIAL DISPARITIES IN THE quality of diabetes mellitus (DM) care and outcomes are well documented. Black patients with DM are less likely than white patients to receive recommended processes of care, including hemoglobin A_{1c} (HbA_{1c}) and lipid testing.^{1,2} Ideal DM treatment goals, such as glycemic, cholesterol, and blood pressure (BP) control

*For editorial comment
see page 1135*

are also less commonly achieved among black patients compared with white patients.³⁻⁸ Ultimately, black patients are more likely than white patients to experience poor long-term diabetic outcomes, including diabetic retinopathy,⁹ lower extremity amputations,^{2,10,11} and chronic kidney disease.¹²

Identifying the underlying reasons and potential solutions for these differences in quality of care and outcomes is a high priority.¹³⁻¹⁵ Although quality improvement programs can eliminate racial disparities in process measures of DM care, disparities in intermediate outcomes often persist,^{6,7} highlighting the importance of monitoring outcomes of care stratified by race. In addition to an increased focus on outcome measures of care, location of care is an increasingly recognized mediator of some racial disparities.¹⁶ Among Medicare enrollees with DM in health plans, approximately two-thirds of racial differences in the control of glucose, cholesterol, and BP are explained by racial differences within health plans, whereas one-third are due to black enrollees receiving treatment in lower-performing health plans.¹⁷

Although prior studies¹⁷⁻²⁰ have focused on the role of hospitals, health plans, and regions as mediators of racial dispari-

ties, little is known about the role of variation among individual physicians. Population-level disparities may arise if black patients disproportionately receive care from physicians who provide lower quality DM care (between-physician effect) or if black patients receive lower quality care than white patients within the same physician's panel (within-physician effect). In addition, features of individual physicians or their patients may predict more equal care for patients. For example, physicians who provide higher overall quality may provide more uniform care and thus be less likely to have large racial differences in care among their patients (ie, smaller within-physician effect). Physicians with a more diverse patient panel may be more comfortable caring for minority patients and thus have smaller racial differences in outcomes among their patients. The use of rigorous hierarchical models to evaluate physician-level effects on health disparities can serve as a model for other health care organizations seeking to understand racial differences in care. These analyses may not capture the full spectrum of explanatory factors related to differential outcomes within a physician's panel, such as complex social and behavioral factors. As such, they should not be used to assign sole responsibility to an individual physician but rather to highlight patterns of variation amenable to focused intervention.

Therefore, our study had the following 2 main objectives: (1) to assess the extent to which racial disparities in intermediate outcomes of DM care are related to within-physician vs between-physician effects and (2) to determine whether overall quality or a more diverse patient panel are associated with decreased racial disparities within individual physicians' patient panels.

METHODS

STUDY SETTING

This study was conducted at Harvard Vanguard Medical Associates (HVMA), an integrated multispecialty group practice consisting of 14 ambulatory health centers in eastern Massachusetts and employing 128 primary care physicians who care for nearly 300 000 adult patients. All clinical practices within HVMA have used a common electronic medical record (EMR) system (Epic Systems, Verona, Wisconsin) since 2000. The system supports computerized ordering of medications and laboratory tests and decision support tools for chronic disease care. All outpatient encounters are entered into the medical record, including clinical notes, diagnostic codes, procedure codes, and all laboratory results. Some physical examination data are documented in coded fields to allow more accurate tracking, including BP, height, and weight. This system also facilitates the creation of disease registries that have been used by HVMA to implement elements of the chronic care model for DM management, including physician-directed electronic decision support tools, team management, and patient education in the form of regular mailings to recommend overdue health services, such as annual low-density lipoprotein cholesterol (LDL-C) testing.^{6,21}

STUDY COHORT

We studied adult patients who were 18 years or older as of May 2007 and who had a diagnosis of DM and a visit with an HVMA

primary care physician during the prior 2 years. A diagnosis of DM was defined as the presence of both (1) a problem list diagnosis of DM and (2) either a fasting plasma glucose level greater than 126 mg/dL, or a random plasma glucose level greater than 200 mg/dL, or a resulted HbA_{1c}.

Patients were linked to an individual primary care physician via a coded field within the EMR. We limited our analyses to primary care physicians who cared for at least 5 white patients and 5 black patients with DM to allow reliable estimates of within-physician racial differences in quality of care and outcomes. This criterion resulted in the inclusion of 90 of the 128 primary care physicians practicing in 13 of the 14 HVMA health centers (70%).

PATIENT VARIABLES

We collected data on patients' age, sex, race, insurance type, and zip code of residence from the EMR. Patients' race was ascertained via self-report at the time of patient registration and office visits. We linked patients' 5-digit zip code of residence to data from the 2000 US Census²² to estimate median household income. Zip code data were available for 99% of patients. We collected additional clinical data from the EMR to adjust for patients' key clinical variables related to DM, including glomerular filtration rate (GFR), body mass index (BMI), and the presence of cardiovascular disease. The GFR, calculated according to the most recent creatinine level using the Modification of Diet in Renal Disease Study equation,²³ was available for 97% of patients. The BMI was calculated based on coded height and weight data and was available for 94% of patients. The presence of cardiovascular disease was defined using outpatient Current Procedural Terminology codes endorsed by standard Health Plan Employer Data and Information Set (HEDIS) criteria.²⁴

OUTCOMES MEASURES

We collected outcome measures consistent with treatment targets recommended by the American Diabetes Association,²⁵ the National Committee for Quality Assurance HEDIS measures,²⁴ and the National Cholesterol Education Program Adult Treatment Panel.²⁶ We defined *ideal* control as HbA_{1c} less than 7%, LDL-C level less than 100 mg/dL, and BP less than 130/80 mm Hg. *Adequate* control was defined as HbA_{1c} level less than 8%, LDL-C level less than 130 mg/dL, and BP less than 140/90 mm Hg. We used the most recent value as of May 2007 to define all outcome measures. Patients without a recorded HbA_{1c} level, LDL-C level, or BP in the measurement year (May 2006 to May 2007) were considered not to have that outcome measure under control. All outcome data were obtained from the EMR system, which has been used extensively in prior analyses of quality of care, including racial disparities in DM care.^{6,27-31} (To convert HbA_{1c} to a proportion of 1.0, multiply by 0.01; to convert LDL-C to millimoles per liter, multiply by 0.0259.)

STATISTICAL ANALYSIS

To estimate racial differences in DM care, we fitted hierarchical linear regression models predicting each of the 3 measures of ideal control and the corresponding 3 measures of adequate control. For each measure, 4 sequential models were fitted to define the contributions of patient characteristics and "within-physician" vs "between-physician" effects: (1) a *baseline model* including patients' race as the only predictor variable; (2) a *sociodemographic model* including patients' race, age, sex, insurance status (commercial insurance, Medicare, Medicaid, or uninsured), and median household income; (3) a *clinical model* including all sociodemographic factors as well as BMI, GFR,

and the presence of cardiovascular disease; and (4) a *physician model* that included all patient characteristics in addition to random-effects terms for both physician and health center.

To explore variation in racial disparities among individual primary care physicians, we modeled the adjusted black-white differences in achieving the 3 ideal outcomes and 3 adequate outcomes within each physician panel using the fully adjusted physician model. This model incorporated fixed effects for race and all patient characteristics in addition to random effects for both physician and health center (conceptually, the hierarchical model is Physician-Level Disparity = Fixed Effects + Random Effect Clinic + Random Effect Physician). The physician effects can be separated into within-physician and between-physician effects. Within-physician effects represent the proportion of racial disparities in DM care attributable to black patients achieving lower control rates than white patients within the same physician's patient panel. Between-physician effects represent the proportion of racial disparities attributable to a disproportionate number of black patients compared with white patients receiving care from physicians who achieve overall lower control rates for DM outcomes.

To estimate the relation between the magnitude of disparity and the number of black patients within individual physician panels, we fitted a second series of models similar to the physician model that also included an interaction term of these 2 factors.

Finally, the fully adjusted physician model also provides an estimate of the correlation between disparities and overall performance at the level of individual physicians. These estimated correlations are derived from the variation and covariation of the random effects at the physician level. For these models, we defined the DM outcomes (HbA_{1c} level, LDL-C level, systolic BP, and diastolic BP) as continuous measures rather than dichotomous measures to increase the stability of our physician-level correlation estimates. All analyses were performed using SAS statistical software (version 9.1; SAS Inc, Cary, North Carolina). The study protocol was approved by the human studies committees at Harvard Vanguard Medical Associates and Brigham and Women's Hospital, Boston, Massachusetts.

RESULTS

We identified 6814 eligible patients with DM treated by 90 primary care physicians (**Table 1**). In this cohort, the median number of white patients per physician was 44.5 (interquartile range, 23.0-65.0; maximum, 165 patients) and of black patients per physician was 15.5 (interquartile range, 8.0-31.0; maximum, 124 patients). There was substantial clustering of care for black patients, with 39% of physicians caring for 75% of black patients. Black patients were younger than white patients, less likely to be male, and lived in communities with lower median household incomes. Racial differences in clinical characteristics were less pronounced.

Rates of receiving annual HbA_{1c} and LDL-C tests were similar among black patients and white patients; however, rates of achieving ideal and adequate control of HbA_{1c}, LDL-C, and BP were significantly lower among black patients compared with white patients (Table 1). The magnitude of these absolute racial differences in achieving ideal control ranged from 6% for BP to 12% for LDL-C; and from 6% for adequate BP control and LDL-C control to 8% for adequate HbA_{1c} control. Black patients were also significantly less likely than white patients to have received a prescription for a statin within the prior 12 months (54% vs 65%; $P < .001$).

Table 1. Sociodemographic and Clinical Characteristics of Study Patients

Characteristic	Patients, No. (%)		P Value
	White (n=4556)	Black (n=2258)	
Age, mean (SD), y	64.7 (13)	58.7 (12)	<.001
Male	2477 (54)	938 (42)	<.001
Median household income, \$	57 580	42 859	<.001
Insurance			
Commercial	2360 (52)	1552 (69)	<.001
Medicare	1966 (43)	495 (22)	
Medicaid	106 (2)	130 (6)	
Uninsured	124 (3)	81 (4)	
BMI, mean (SD)	32.3 (7)	32.7 (7)	.01
Cardiovascular disease	483 (10)	164 (7)	<.001
GFR, mean (SD), mL/min/1.73 m ²	71.8 (23)	83.0 (26)	<.001
Annual HbA _{1c} test	4081 (90)	2012 (89)	.55
Annual LDL-C test	3802 (83)	1879 (83)	.81
Statin prescription	2945 (65)	1218 (54)	<.001
HbA _{1c} control			
<7.0	2146 (47)	872 (39)	<.001
<8.0	3223 (71)	1421 (63)	<.001
LDL-C control, mg/dL			
<100	2619 (57)	1022 (45)	<.001
<130	3416 (75)	1549 (69)	<.001
BP control, mm Hg			
<130/80	1385 (30)	531 (24)	<.001
<140/90	2855 (63)	1279 (57)	<.001

Abbreviations: BMI, body mass index (calculated as weight in kilograms divided by height in meters squared); BP, blood pressure; GFR, glomerular filtration rate; HbA_{1c}, hemoglobin A_{1c}; LDL-C, low-density lipoprotein cholesterol. SI conversion factors: To convert HbA_{1c} to a proportion of 1.0, multiply by 0.01; to convert LDL-C to millimoles per liter, multiply by 0.0259.

Results from the hierarchical linear regression models consistently indicated that adjustment for patients' sociodemographic factors played a substantial role in explaining racial disparities in control of HbA_{1c} and LDL-C, accounting for 13% to 38% of observed racial differences in achieving ideal control of HbA_{1c}, LDL-C, and BP (**Table 2**). For example, the unadjusted black-white difference in rates of achieving ideal LDL-C control declined from -12.2% to -8.1%, a relative change of approximately 34%. Adjustment for patients' clinical factors uniformly explained little to none of the observed overall racial differences in outcomes, whereas adjustment for between-physician effects explained only a small proportion of the disparities. For example, although adjustment for patients' sociodemographic characteristics resulted in a substantial decrease in the observed racial disparity of achieving ideal LDL-C control to -8.1%, further adjustment for patients' clinical factors and between-physician effects resulted in little additional change (to -8.2% and -8.3%, respectively) in the observed disparity.

In contrast to these small between-physician effects, within-physician effects explained a large percentage of racial disparities in achieving ideal DM outcomes, ranging from 66% for HbA_{1c} control to 68% for LDL-C control to 75% for BP control (**Figure 1**). Between-physician effects played an important role in achieving ideal BP control, where it accounted for 23% of the disparity.

Table 2. Impact of Patient Characteristics and Physicians on Racial Disparities in DM Care

Characteristic	Difference for Black vs White Patients According to Type of Model, %			
	Unadjusted Model ^a	Sociodemographic Model ^b	Clinical Model ^c	Physician Model ^d
HbA _{1c} control				
<7.0	-8.5	-5.3	-6.1	-5.6
<8.0	-7.8	-3.9	-4.8	-4.4
LDL-C control, mg/dL				
<100	-12.2	-8.1	-8.2	-8.3
<130	-6.4	-2.9	-3.6	-3.7
BP control, mm Hg				
<130/80	-6.9	-6.0	-6.8	-5.2
<140/90	-6.0	-5.4	-6.5	-5.9

Abbreviations: BP, blood pressure; DM, diabetes mellitus; HbA_{1c}, hemoglobin A_{1c}; LDL-C, low-density lipoprotein cholesterol.

SI conversion factors: To convert HbA_{1c} to a proportion of 1.0, multiply by 0.01; to convert LDL-C to millimoles per liter, multiply by 0.0259.

^aUnadjusted model contains only race as a covariate.

^bSociodemographic model includes covariates for patient age, sex, income, and insurance status.

^cClinical model includes all covariates from sociodemographic model plus patient body mass index, glomerular filtration rate, and presence of cardiovascular disease.

^dPhysician model includes all covariates from clinical model plus random effects terms for health center and physician.

Among individual primary care physicians, there was notable variation in the magnitude of racial disparities in ideal DM outcomes after adjusting for patient characteristics (**Figure 2**). However, we found no statistically significant association between the magnitude of racial disparities in a physician's panel of patients and the number of black patients treated by that physician (**Figure 2**). There were also no statistically significant correlations between overall rates of achieving ideal control and racial disparities within individual physician panels (see **Table 3** for *P* values).

COMMENT

Understanding the underlying mediators of racial disparities in DM outcomes is essential to develop solutions to eliminate these differences in outcomes. We examined the complex interactions among patients' sociodemographic characteristics, comorbid conditions, and variations in performance measures among individual physicians. We found that patients' sociodemographic characteristics explained a substantial proportion of racial disparities in DM outcomes, whereas patients' clinical characteristics did not play a major role. Most of the remaining racial disparities by far were attributable to within-physician effects instead of between-physician effects. Thus, racial differences in outcomes were not related to black patients differentially receiving care from physicians who provide a lower quality of care, but rather that black patients experienced less ideal or even adequate outcomes than white patients within the same physician panel.

These findings are consistent with a previously published study¹⁷ of racial disparities in DM care that found

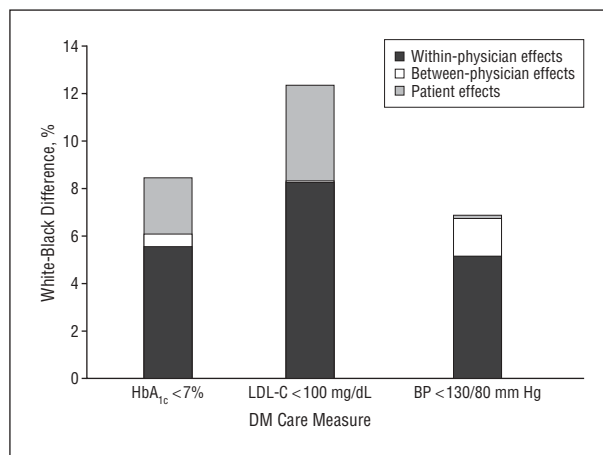


Figure 1. Contributions to overall racial disparities in achieving ideal diabetes mellitus (DM) control are indicated for 3 DM care measures based on fully adjusted hierarchical models. Patient effects represent those disparities explained by patient age, sex, income, insurance, body mass index, glomerular filtration rate, and presence of cardiovascular disease. To convert hemoglobin A_{1c} (HbA_{1c}) to a proportion of 1.0, multiply by 0.01; to convert low-density lipoprotein cholesterol (LDL-C) to millimoles per liter, multiply by 0.0259. BP indicates blood pressure.

that most racial differences in both HbA_{1c} and LDL-C control were attributable to within-health plan differences as opposed to between-health plan differences. Our study extends these findings in 2 important ways. First, we were able to include an analysis of the relative contributions of patients' sociodemographic and clinical characteristics and found that sociodemographic variables were important confounders of the relationship between race and quality of care. In contrast to standard HEDIS quality reporting, in which case-mix adjustment has only a limited effect,³² reporting of racial disparities for quality improvement purposes may need to consider such adjustments. Second, we were able to discern the contributions of individual physicians to racial disparities, as opposed to larger units of the health care system, such as health plans. Primary care clinical encounters play an important role in DM care,³³ and these encounters may play a role in racial disparities.³⁴

Prior studies³⁵⁻³⁸ have analyzed variation in DM quality of care by physician practice group and individual primary care physician, identifying variations in quality at multiple levels within the health care system. For each of the 3 outcomes measures assessed, we identified substantial variation in racial disparities in DM outcomes among individual physician panels even after adjusting for patients' sociodemographic and clinical characteristics. However, our analyses did not find an association between this variation and either the numbers of black patients treated or the overall performance of individual physicians. The lack of any statistically discernible correlation between overall performance and racial disparities is consistent with 1 previous study¹⁷ of health plan performance.

How can our findings be used to guide interventions to reduce racial disparities in DM care and outcomes? Because we found small between-physician effects, shifting care for black patients among individual physicians within a large physician practice group is unlikely to be

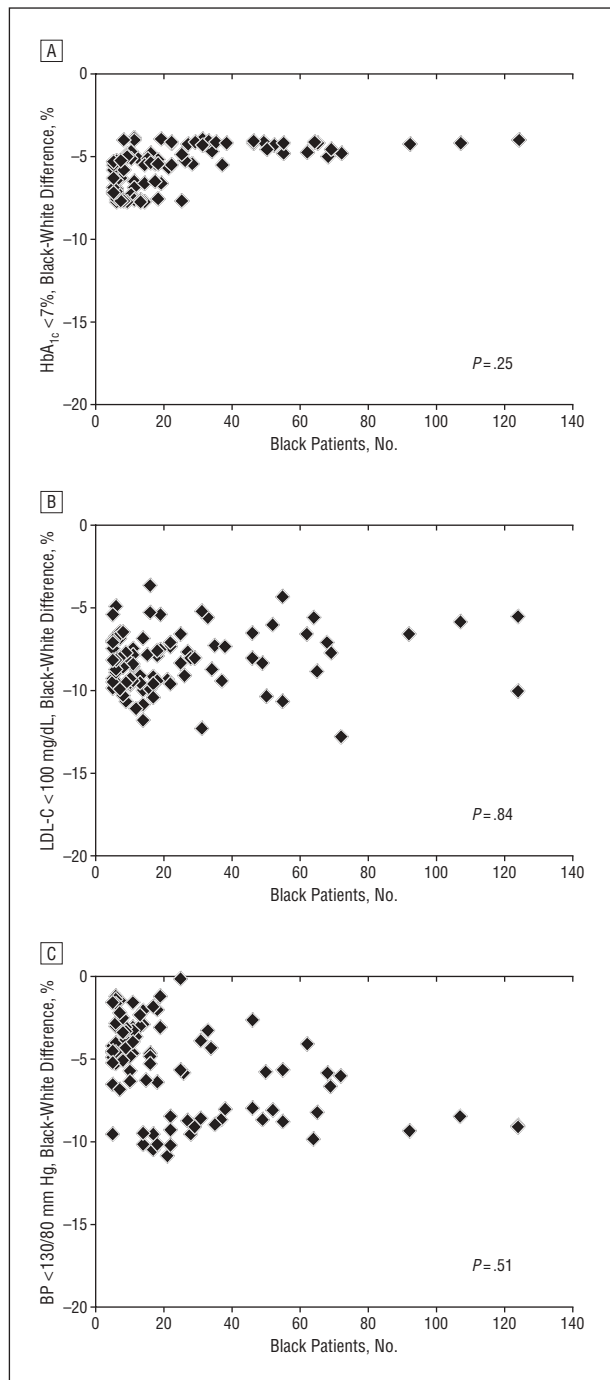


Figure 2. Physician-level variation in racial disparities in achieving ideal diabetes mellitus (DM) control for 3 DM care measures after adjusting for patient age, sex, income, insurance, body mass index, glomerular filtration rate, and presence of cardiovascular disease. A, Hemoglobin A_{1c} (HbA_{1c}); median variation, -5.3 ; interquartile range (IQR), -4.3 to -6.6 . B, Low-density lipoprotein cholesterol (LDL-C); median variation, -8.0 ; IQR, -6.9 to -9.4 . C, Blood pressure (BP); median variation, -4.9 ; IQR, -3.3 to -8.5 . Each diamond represents an individual physician's patient panel. *P* values represent the test of statistical significance for the interaction between magnitude of racial disparities and volume of black patients cared for within individual physician panels. To convert HbA_{1c} to a proportion of 1.0, multiply by 0.01; to convert LDL-C to millimoles per liter, multiply by 0.0259.

an effective policy solution to eliminate racial disparities in DM care. Neither does it seem that physicians who achieve high overall performance or who treat a large volume of black patients are particularly more effective in

Table 3. Correlation Between Adjusted Racial Disparities in DM Outcomes and Overall Performance Among Individual Physicians^a

Control	Correlation Coefficient	<i>P</i> Value
HbA _{1c}	0.64	.40
LDL-C	-0.54	.87
SBP	-0.31	.81
DBP	-0.17	.85

Abbreviations: DBP, diastolic blood pressure; DM, diabetes mellitus; HbA_{1c}, hemoglobin A_{1c}; LDL-C, low-density lipoprotein cholesterol; SBP, systolic blood pressure.

^aCorrelations calculated using clinical outcomes as continuous variables. Negative correlations indicate that higher quality is associated with a smaller racial disparity.

achieving equal outcomes by race. Our results rather suggest that efforts will need to be directed across all physicians, with a special emphasis on delivering effective care to minority patients with DM.

Perhaps the most important potential use of these data is for physician education regarding the importance of patient race in their own local health care environment. A prior survey found that one-third of cardiologists acknowledged the existence of racial disparities in cardiac care on a national level, but less than 5% of cardiologists reported such differences within their own panel of patients.³⁹ Our data suggest that the problem of racial disparities is not characterized by only a few physicians providing markedly unequal care, but that such differences in care are spread across the entire system, requiring the implementation of system-wide solutions. Given the important role of patient sociodemographic features in racial disparities in DM care identified in our study, these solutions will need to be implemented in a manner that supports physicians as they attempt to address not only problems in their own health care environment but also social factors outside the health care system. Potential solutions may therefore involve more effective community engagement on the part of the health care system or increased patient education and contact outside of the typical office visit.

It is important to note that prior concerns have been raised regarding the reliability of physician-level reports for DM care.³⁶ We agree that caution is appropriate in the use of such reports; however, 1 prior analysis,³⁶ based on the Spearman-Brown prediction formula, indicated that reliability coefficients of approximately 0.76 for individual physician comparisons could be achieved when diabetic panel sizes approach 75 patients per physician, which was the mean panel size in our study sample. Therefore, given sufficient numbers of patients per physician, our method of using comprehensive EMR data to identify all patients cared for by an individual physician produces profiles that can be used reliably for internal quality improvement programs.

Our data also indicate inherent difficulties with reporting disparities for individual physicians. Using a relatively low threshold for inclusion of at least 5 black patients and 5 white patients with DM, we excluded 30% of the physicians and 1 of the 14 health centers but nonetheless ex-

cluded only 4% of all black patients with DM being treated within the health care organization. In addition, the ability to analyze physician-level contributions to racial disparities in outcomes is critically dependent on the availability of accurate clinical data on each physician's entire panel of patients, regardless of payer status or age—limitations that may arise if trying to do such reporting using administrative data or data from a single health plan. The steadily increasing use of EMRs may provide an effective solution to this important data limitation.⁴⁰

Our findings should be interpreted in the context of additional study limitations. These analyses were conducted within a multispecialty practice group using a well-established advanced EMR system and providing DM care guided by the Chronic Care Model.^{41,42} The shared EMR system and centralized management structure of HVMA, along with the system of coordinated care among primary care teams, may have resulted in more uniform care across primary care physicians. Between-physician effects may be more prominent when analyzing care across other health care systems or multiple different settings.

We were also limited in our ability to identify underlying differences in physician practice patterns that may lead to the observed variation in outcomes. Although we identified important racial differences in the prescribing of cholesterol-lowering medications, which likely plays a prominent role in persistent disparities in cholesterol control,⁶ we did not have detailed information regarding other, more complex, components of DM care that could contribute to disparities, such as insulin regimens, DM education, or exercise counseling. Our analyses may have also underestimated the role of income through our use of zip code estimates of income rather than more sensitive census block group-level estimates.⁴³ However, some data indicate that these 2 methods produce equivalent adjustments when assessing performance at the individual physician level,⁴⁴ and that adjustments using these 2 methods have a similar impact on racial disparities in mortality.⁴⁵

In addition, we did not have information available regarding social factors that may contribute to racial differences in outcomes but are potentially outside individual physicians' control, including affordability of medications,⁴⁶ access to affordable nutritious foods,⁴⁷ and opportunities for physical activity in local communities.^{48,49} One potential use of physician profiling regarding racial disparities in DM care would be to encourage physicians to explore some of these contextual issues to develop a care plan in closer collaboration with patients that accounts for these broader aspects of their lives. Finally, our study focused only on white-black differences in care because the numbers of Hispanic and Asian patients with DM were too small to support physician-level analyses; it is possible that a very different dynamic may occur for these other racial and ethnic groups.

In conclusion, we found that a substantial proportion of racial disparities in DM care are primarily related to within-physician differences in outcomes. In addition, the substantial physician-level variation in DM care was not related to overall performance or volume of black patients treated, suggesting that system-wide interven-

tions will be needed to improve care for minority patients across all physicians.

Accepted for Publication: December 10, 2007.

Correspondence: Thomas D. Sequist, MD, MPH, Division of General Medicine, Brigham and Women's Hospital, 1620 Tremont St, Boston, MA 02120 (tsequist@partners.org).

Author Contributions: Dr Sequist had full access to all the data in the study and takes responsibility for the integrity and the accuracy of the data analysis. *Study concept and design:* Sequist, Marshall, Safran, and Ayanian. *Acquisition of data:* Sequist and Marshall. *Analysis and interpretation of data:* Sequist, Fitzmaurice, Marshall, Shaykevich, Safran, and Ayanian. *Drafting of the manuscript:* Sequist, Fitzmaurice, and Safran. *Critical revision of the manuscript for important intellectual content:* Sequist, Fitzmaurice, Marshall, Shaykevich, Safran, and Ayanian. *Statistical analysis:* Sequist, Fitzmaurice, and Shaykevich. *Obtained funding:* Sequist, Marshall, and Safran. *Administrative, technical, and material support:* Sequist, Marshall, and Safran. *Study supervision:* Sequist.

Financial Disclosure: Dr Sequist serves as a consultant on the Aetna External Advisory Committee for Racial and Ethnic Equality. Dr Ayanian serves as a consultant to RTI International and DxCG Inc.

Funding/Support: This study was funded by the Robert Wood Johnson Foundation Finding Answers: Disparities Research for Change national program.

Role of the Sponsors: The funding organization played no role in the design and conduct of the study; collection, management, analysis, and interpretation of data; or in preparation, review, or approval of the manuscript.

Previous Presentation: This study was presented at the Annual Meeting of the Society of General Internal Medicine; April 26, 2007; Toronto, Ontario, Canada.

Additional Contributions: Amy Marston, BA, of HVMA assisted with project management.

REFERENCES

1. Virnig BA, Lurie N, Huang Z, Musgrave D, McBean AM, Dowd B. Racial variation in quality of care among Medicare + Choice enrollees. *Health Aff (Millwood)*. 2002;21(6):224-230.
2. Agency for Healthcare Research Quality. National Healthcare Disparities Report. <http://www.ahrq.gov/qual/nhdr06/nhdr06.htm>. Accessed October 22, 2007.
3. Harris MI, Eastman RC, Cowie CC, Flegal KM, Eberhardt MS. Racial and ethnic differences in glycemic control of adults with type 2 diabetes. *Diabetes Care*. 1999; 22(3):403-408.
4. Kirk JK, D'Agostino RB Jr, Bell RA, et al. Disparities in HbA1c levels between African-American and non-Hispanic white adults with diabetes: a meta-analysis. *Diabetes Care*. 2006;29(9):2130-2136.
5. McBean AM, Huang Z, Virnig BA, Lurie N, Musgrave D. Racial variation in the control of diabetes among elderly Medicare managed care beneficiaries. *Diabetes Care*. 2003;26(12):3250-3256.
6. Sequist TD, Adams A, Zhang F, Ross-Degnan D, Ayanian JZ. Effect of quality improvement on racial disparities in diabetes care. *Arch Intern Med*. 2006; 166(6):675-681.
7. Trivedi AN, Zaslavsky AM, Schneider EC, Ayanian JZ. Trends in the quality of care and racial disparities in Medicare managed care. *N Engl J Med*. 2005; 353(7):692-700.
8. Brown AF, Gregg EW, Stevens MR, et al. Race, ethnicity, socioeconomic position, and quality of care for adults with diabetes enrolled in managed care: the Translating Research Into Action for Diabetes (TRIAD) study. *Diabetes Care*. 2005; 28(12):2864-2870.
9. Harris MI, Klein R, Cowie CC, Rowland M, Byrd-Holt DD. Is the risk of diabetic

- retinopathy greater in non-Hispanic blacks and Mexican Americans than in non-Hispanic whites with type 2 diabetes? a U.S. population study. *Diabetes Care*. 1998;21(8):1230-1235.
10. Gornick ME, Eggers PW, Reilly TW, et al. Effects of race and income on mortality and use of services among Medicare beneficiaries. *N Engl J Med*. 1996; 335(11):791-799.
 11. Young BA, Maynard C, Reiber G, Boyko EJ. Effects of ethnicity and nephropathy on lower-extremity amputation risk among diabetic veterans. *Diabetes Care*. 2003; 26(2):495-501.
 12. Young BA, Maynard C, Boyko EJ. Racial differences in diabetic nephropathy, cardiovascular disease, and mortality in a national population of veterans. *Diabetes Care*. 2003;26(8):2392-2399.
 13. Chin MH, Walters AE, Cook SC, Huang ES. Interventions to reduce racial and ethnic disparities in health care. *Med Care Res Rev*. 2007;64(5)(suppl):7S-28S.
 14. Peek ME, Cargill A, Huang ES. Diabetes health disparities: a systematic review of health care interventions. *Med Care Res Rev*. 2007;64(5)(suppl):101S-156S.
 15. Lurie N. Health disparities: less talk, more action. *N Engl J Med*. 2005;353(7):727-729.
 16. Zaslavsky AM, Ayanian JZ. Integrating research on racial and ethnic disparities in health care over place and time. *Med Care*. 2005;43(4):303-307.
 17. Trivedi AN, Zaslavsky AM, Schneider EC, Ayanian JZ. Relationship between quality of care and racial disparities in Medicare health plans. *JAMA*. 2006;296(16):1998-2004.
 18. Barnato AE, Lucas FL, Staiger D, Wennberg DE, Chandra A. Hospital-level racial disparities in acute myocardial infarction treatment and outcomes. *Med Care*. 2005;43(4):308-319.
 19. Rathore SS, Masoudi FA, Havranek EP, Krumholz HM. Regional variations in racial differences in the treatment of elderly patients hospitalized with acute myocardial infarction. *Am J Med*. 2004;117(11):811-822.
 20. Skinner J, Chandra A, Staiger D, Lee J, McClellan M. Mortality after acute myocardial infarction in hospitals that disproportionately treat black patients. *Circulation*. 2005;112(17):2634-2641.
 21. Kimura J, DaSilva K, Marshall R. Population management, systems-based practice, and planned chronic illness care: integrating disease management competencies into primary care to improve composite diabetes quality measures. *Dis Manage*. 2008;11(1):13-22.
 22. US Census 2000. US Census Bureau Web site. <http://www.census.gov/main/www/cen2000.html>. Accessed March 17, 2008.
 23. Levey AS, Bosch JP, Lewis JB, Greene T, Rogers N, Roth D; Modification of Diet in Renal Disease Study Group. A more accurate method to estimate glomerular filtration rate from serum creatinine: a new prediction equation. *Ann Intern Med*. 1999;130(6):461-470.
 24. HEDIS and quality management. National Center for Quality Assurance Web site. <http://www.ncqa.org/tabid/59/Default.aspx>. Accessed March 17, 2008.
 25. American Diabetes Association. Standards of medical care in diabetes: 2006. *Diabetes Care*. 2006;29(suppl 1):S4-S42.
 26. National Cholesterol Education Program. Executive Summary of the Third Report of the National Cholesterol Education Program (NCEP) expert panel on detection, evaluation, and treatment of high blood cholesterol in adults (adult treatment panel III). *JAMA*. 2001;285(19):2486-2497.
 27. Barton MB, Dayhoff DA, Soumerai SB, Rosenbach ML, Fletcher RH. Measuring access to effective care among elderly Medicare enrollees in managed and fee-for-service care: a retrospective cohort study. *BMC Health Serv Res*. 2001;1(1):11.
 28. Pereira AG, Kleinman KP, Pearson SD. Leaving the practice: effects of primary care physician departure on patient care. *Arch Intern Med*. 2003;163(22):2733-2736.
 29. Sequist TD, Marshall R, Lampert S, Buechler EJ, Lee TH. Missed opportunities in the primary care management of early acute ischemic heart disease. *Arch Intern Med*. 2006;166(20):2237-2243.
 30. Grant R, Adams AS, Trinacty CM, et al. Relationship between patient medication adherence and subsequent clinical inertia in type 2 diabetes glycemic management. *Diabetes Care*. 2007;30(4):807-812.
 31. Adams AS, Zhang F, Mah C, et al. Race differences in long-term diabetes management in an HMO. *Diabetes Care*. 2005;28(12):2844-2849.
 32. Zaslavsky AM, Hochheimer JN, Schneider EC, et al. Impact of sociodemographic case mix on the HEDIS measures of health plan quality. *Med Care*. 2000; 38(10):981-992.
 33. Rothman AA, Wagner EH. Chronic illness management: what is the role of primary care? *Ann Intern Med*. 2003;138(3):256-261.
 34. Schulman KA, Berlin JA, Harless W, et al. The effect of race and sex on physicians' recommendations for cardiac catheterization. *N Engl J Med*. 1999;340(8):618-626.
 35. Weiner JP, Parente ST, Garnick DW, Fowles J, Lawthers AG, Palmer RH. Variation in office-based quality: a claims-based profile of care provided to Medicare patients with diabetes. *JAMA*. 1995;273(19):1503-1508.
 36. Hofer TP, Hayward RA, Greenfield S, Wagner EH, Kaplan SH, Manning WG. The unreliability of individual physician "report cards" for assessing the costs and quality of care of a chronic disease. *JAMA*. 1999;281(22):2098-2105.
 37. Krein SL, Hofer TP, Kerr EA, Hayward RA. Whom should we profile? examining diabetes care practice variation among primary care providers, provider groups, and health care facilities. *Health Serv Res*. 2002;37(5):1159-1180.
 38. Greenfield S, Kaplan SH, Kahn R, Ninomiya J, Griffith JL. Profiling care provided by different groups of physicians: effects of patient case-mix (bias) and physician-level clustering on quality assessment results. *Ann Intern Med*. 2002;136(2):111-121.
 39. Lurie N, Fremont A, Jain AK, et al. Racial and ethnic disparities in care: the perspectives of cardiologists. *Circulation*. 2005;111(10):1264-1269.
 40. Jha AK, Ferris TG, Donelan K, et al. How common are electronic health records in the United States? a summary of the evidence. *Health Aff (Millwood)*. 2006; 25:w496-507.
 41. Bodenheimer T, Wagner EH, Grumbach K. Improving primary care for patients with chronic illness. *JAMA*. 2002;288(14):1775-1779.
 42. Bodenheimer T, Wagner EH, Grumbach K. Improving primary care for patients with chronic illness: the chronic care model, part 2. *JAMA*. 2002;288(15):1909-1914.
 43. Krieger N, Chen JT, Waterman PD, Soobader MJ, Subramanian SV, Carson R. Geocoding and monitoring of US socioeconomic inequalities in mortality and cancer incidence: does the choice of area-based measure and geographic level matter? the Public Health Disparities Geocoding Project. *Am J Epidemiol*. 2002; 156(5):471-482.
 44. Fiscella K, Franks P. Impact of patient socioeconomic status on physician profiles: a comparison of census-derived and individual measures. *Med Care*. 2001; 39(1):8-14.
 45. Thomas AJ, Eberly LE, Davey Smith G, Neaton JD. ZIP-code-based versus tract-based income measures as long-term risk-adjusted mortality predictors. *Am J Epidemiol*. 2006;164(6):586-590.
 46. Gaskin DJ, Briesacher BA, Limcangco R, Briganti BL. Exploring racial and ethnic disparities in prescription drug spending and use among Medicare beneficiaries. *Am J Geriatr Pharmacother*. 2006;4(2):96-111.
 47. Horowitz CR, Colson KA, Hebert PL, Lancaster K. Barriers to buying healthy foods for people with diabetes: evidence of environmental disparities. *Am J Public Health*. 2004;94(9):1549-1554.
 48. Bolen JC, Rhodes L, Powell-Griner EE, Bland SD, Holtzman D. State-specific prevalence of selected health behaviors, by race and ethnicity: Behavioral Risk Factor Surveillance System, 1997. *MMWR CDC Surveill Summ*. 2000;49(2):1-60.
 49. Montgomery S, Herring P, Yancey A, et al. Comparing self-reported disease outcomes, diet, and lifestyles in a national cohort of black and white Seventh-Day Adventists. *Prev Chronic Dis*. 2007;4(3):A62.