Physician Performance and Racial Disparities in Diabetes Mellitus Care

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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 A1c (HbA1c) (<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 HbA1c (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

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ties, little is known about the role of variation among indi-

cidual physicians. Population-level disparities may arise

if black patients disproportionately receive care from phy-
sicians who provide lower quality DM care (between-

physician effect) or if black patients receive lower qual-

ity 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 pro-

vide higher overall quality may provide more uniform

care and thus be less likely to have large racial differ-

ces in care among their patients (ie, smaller within-

physician effect). Physicians with a more diverse pa-

tient panel may be more comfortable caring for minority

patients and thus have smaller racial differences in out-

comes among their patients. The use of rigorous hierar-

chical models to evaluate physician-level effects on health
disparities can serve as a model for other health care or-
ganizations 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 fo-
cused intervention.

Therefore, our study had the following 2 main objec-
tives: (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 deter-

mine 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 Medi-

cal Associates (HVMA), an integrated multispecialty group practice con-
sisting 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

counterpoint ordering of medications and laboratory tests and
decision support tools for chronic disease care. All outpatient

counters are entered into the medical record, including clinical

notes, diagnostic codes, procedure codes, and all laboratory re-

sults. 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 regis-

tries 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

outdoor health services, such as annual low-density lipoprotein

cholesterol (LDL-C) testing.

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 di-

agnosis 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 resultant HbA1c.

Patients were linked to an individual primary care physi-

cian via a coded field within the EMR. We limited our analy-

ses to primary care physicians who cared for at least 5 white

patients and 5 black patients with DM to allow reliable esti-

mates 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 ascer-
	ained 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 Census to estimate median household in-
come. Zip code data were available for 99% of patients. We col-
lected additional clinical data from the EMR to adjust for pa-

tients’ 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 Re-
nal Disease Study equation, 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 car-
diovascular disease was defined using outpatient Current Proce-
dural Terminology codes endorsed by standard Health Plan

Employer Data and Information Set (HEDIS) criteria.

OUTCOMES MEASURES

We collected outcome measures consistent with treatment tar-

gets recommended by the American Diabetes Association, the

National Committee for Quality Assurance HEDIS mea-

sures, and the National Cholesterol Education Program Adult

Treatment Panel. We defined ideal control as HbA1c less

than 7%, LDL-C level less than 100 mg/dL, and BP less than

130/80 mm Hg. Adequate control was defined as HbA1c 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 HbA1c

level, LDL-C level, or BP in the measurement year (May 2006

to May 2007) were considered not to have that outcome mea-

sure under control. All outcome data were obtained from the

EMR system, which has been used extensively in prior analy-

ses of quality of care, including racial disparities in DM care.

(To convert HbA1c to a proportion of 1.0, multiply by 0.01; to

calculate LDL-C to millimoles per liter, multiply by 0.0259.)

STATISTICAL ANALYSIS

To estimate racial differences in DM care, we fitted hierarchi-

cal 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 so-
ciodemographic model including patients’ race, age, sex, insur-

ance status (commercial insurance, Medicare, Medicaid, or un-

insured), 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 (HbA1c 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 HbA1c and LDL-C tests were similar among black patients and white patients; however, rates of achieving ideal and adequate control of HbA1c, 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 HbA1c 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

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>White (n=4656)</th>
<th>Black (n=2258)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, mean (SD), y</td>
<td>64.7 (13)</td>
<td>58.7 (12)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Male</td>
<td>2477 (54)</td>
<td>938 (42)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Median household income, $</td>
<td>57 580</td>
<td>42 859</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Medicaid</td>
<td>1966 (43)</td>
<td>495 (22)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Commercial</td>
<td>2380 (52)</td>
<td>1552 (69)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Medicare</td>
<td>106 (2)</td>
<td>130 (6)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Uninsured</td>
<td>124 (3)</td>
<td>81 (4)</td>
<td>.01</td>
</tr>
<tr>
<td>BMI, mean (SD)</td>
<td>32.3 (7)</td>
<td>32.7 (7)</td>
<td>.01</td>
</tr>
<tr>
<td>Cardiovascular disease</td>
<td>483 (10)</td>
<td>164 (7)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>GFR, mean (SD), ml/min/1.73 m²</td>
<td>71.8 (23)</td>
<td>83.0 (26)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Annual HbA1c test</td>
<td>2146 (47)</td>
<td>872 (39)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Annual LDL-C test</td>
<td>3223 (71)</td>
<td>1421 (63)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Statin prescription</td>
<td>2619 (57)</td>
<td>1022 (45)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>LDL-C control, mg/dL</td>
<td>3416 (75)</td>
<td>1549 (69)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>&lt;100</td>
<td>1385 (30)</td>
<td>531 (24)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>BP control, mm Hg</td>
<td>2855 (69)</td>
<td>1279 (57)</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

Abbreviations: BMI, body mass index (calculated as weight in kilograms divided by height in meters squared); BP, blood pressure; GFR, glomerular filtration rate; HbA1c, hemoglobin A1c; LDL-C, low-density lipoprotein cholesterol.

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 HbA1c and LDL-C, accounting for 13% to 38% of observed racial differences in achieving ideal control of HbA1c, 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 HbA1c 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.
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).

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

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Unadjusted Modela</th>
<th>Sociodemographic Modelb</th>
<th>Clinical Modelc</th>
<th>Physician Modeld</th>
</tr>
</thead>
<tbody>
<tr>
<td>HbA1c control</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;7.0</td>
<td>−8.5</td>
<td>−5.3</td>
<td>−6.1</td>
<td>−5.6</td>
</tr>
<tr>
<td>&lt;8.0</td>
<td>−7.8</td>
<td>−3.9</td>
<td>−4.8</td>
<td>−4.4</td>
</tr>
<tr>
<td>LDL-C control, mg/dL</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;100</td>
<td>−12.2</td>
<td>−8.1</td>
<td>−8.2</td>
<td>−8.3</td>
</tr>
<tr>
<td>&lt;130</td>
<td>−6.4</td>
<td>−2.9</td>
<td>−3.6</td>
<td>−3.7</td>
</tr>
<tr>
<td>BP control, mm Hg</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;130/80</td>
<td>−6.9</td>
<td>−6.0</td>
<td>−6.8</td>
<td>−5.2</td>
</tr>
<tr>
<td>&lt;140/90</td>
<td>−6.0</td>
<td>−5.4</td>
<td>−6.5</td>
<td>−5.9</td>
</tr>
</tbody>
</table>

Abbreviations: BP, blood pressure; DM, diabetes mellitus; HbA1c, hemoglobin A1c; LDL-C, low-density lipoprotein cholesterol.

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.

that most racial differences in both HbA1c 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 study37 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 A1c (HbA1c); 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, −8.0; IQR, −6.9 to −9.4.

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

<table>
<thead>
<tr>
<th>Control</th>
<th>Correlation Coefficient</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>HbA1c</td>
<td>0.64</td>
<td>.40</td>
</tr>
<tr>
<td>LDL-C</td>
<td>−0.54</td>
<td>.87</td>
</tr>
<tr>
<td>SBP</td>
<td>−0.31</td>
<td>.81</td>
</tr>
<tr>
<td>DBP</td>
<td>−0.17</td>
<td>.85</td>
</tr>
</tbody>
</table>

Abbreviations: DBP, diastolic blood pressure; DM, diabetes mellitus; HbA1c, hemoglobin A1c; LDL-C, low-density lipoprotein cholesterol; SBP, systolic blood pressure.

A Correlations 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.

It is important to note that prior concerns have been raised regarding the reliability of physician-level reports for DM care. We agree that caution is appropriate in the use of such reports; however, 1 prior analysis, 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.

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.49 However, some data indicate that these 2 methods produce equivalent adjustments when assessing performance at the individual physician level,49 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 interventions will be needed to improve care for minority patients across all physicians.

Accepted for Publication: December 10, 2007.
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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.

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