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.

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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 A1c (HbA1c) and lipid testing.1,2 Ideal DM treatment goals, such as glycemic, cholesterol, and blood pressure (BP) control are also less commonly achieved among black patients compared with white patients.1-8 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 (i.e., 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 registers 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 result of HbA1c.

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 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 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 HbA1c 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. 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 resulted in a substantial decrease in the proportion of physicians caring for 75% of black patients compared with white patients (Table 1).

<p>| Table 1. Sociodemographic and Clinical Characteristics of Study Patients |
|---------------------|---------------------|---------------------|---------------------|---------------------|</p>
<table>
<thead>
<tr>
<th>Patients, No. (%)</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>57580</td>
<td>42859</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Insurance</td>
<td>Commercial</td>
<td>2360 (52)</td>
<td>1552 (69)</td>
</tr>
<tr>
<td></td>
<td>Medicare</td>
<td>1966 (43)</td>
<td>495 (22)</td>
</tr>
<tr>
<td></td>
<td>Medicaid</td>
<td>106 (2)</td>
<td>130 (6)</td>
</tr>
<tr>
<td></td>
<td>Commercial</td>
<td>124 (3)</td>
<td>81 (4)</td>
</tr>
<tr>
<td>BMI, mean (SD)</td>
<td>32.3 (7)</td>
<td>32.7 (7)</td>
<td>0.1</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>14081 (90)</td>
<td>2012 (89)</td>
<td>.55</td>
</tr>
<tr>
<td>Annual LDL-C test</td>
<td>3802 (83)</td>
<td>1679 (83)</td>
<td>.81</td>
</tr>
<tr>
<td>Statin prescription</td>
<td>2945 (65)</td>
<td>1218 (54)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>HbA₁c control</td>
<td>&lt;7.0</td>
<td>2146 (47)</td>
<td>872 (39)</td>
</tr>
<tr>
<td></td>
<td>&lt;8.0</td>
<td>3223 (71)</td>
<td>1421 (63)</td>
</tr>
<tr>
<td>LDL-C control, mg/dL</td>
<td>&lt;100</td>
<td>2619 (57)</td>
<td>1022 (45)</td>
</tr>
<tr>
<td></td>
<td>&lt;130</td>
<td>3416 (75)</td>
<td>1549 (69)</td>
</tr>
<tr>
<td>BP control, mm Hg</td>
<td>&lt;130/80</td>
<td>1385 (30)</td>
<td>531 (24)</td>
</tr>
<tr>
<td></td>
<td>&lt;140/90</td>
<td>2855 (63)</td>
<td>1279 (57)</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).

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 study of racial disparities in DM care that found 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

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

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

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**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 A1c (HbA1c) to a proportion of 1.0, multiply by 0.01; to convert LDL-C to millimoles per liter, multiply by 0.0259. BP indicates 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. 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. 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. 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. 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.¹¹,¹² 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.⁴⁵ However, some data indicate that these 2 methods produce equivalent adjustments when assessing performance at the individual physician level,⁴⁶ 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,⁶⁶ access to affordable nutritious foods,⁶⁷ and opportunities for physical activity in local communities.⁶⁸,⁶⁹ 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.

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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.

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

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