Relationship Between Patient Panel Characteristics and Primary Care Physician Clinical Performance Rankings

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Physicians have increasingly become the focus of quality performance measurement. Many health care systems now use physician clinical performance assessment as part of their re-credentialing process—to support health care choices for consumers and to guide quality improvement and cost-containment efforts. Partly in response to significant variation in the quality of care, pay-for-performance and public reporting programs have become widely adopted approaches to influence clinician performance. These programs use performance incentives including cash payments and public reports to motivate clinicians, practice groups, and health care systems to achieve specific health care quality goals.

An intrinsic assumption underlying physician clinical performance assessment is that the measures represent physician performance. However, the same physician may have higher or lower measured quality scores depending on the panel of patients he or she manages. The association of patient panel characteristics with physician quality scores could lead to inaccurate physician clinical performance rankings that could have implications on how physicians are rewarded and on how resources are allocated within health care systems.

Context  Physicians have increasingly become the focus of clinical performance measurement.

Objective  To investigate the relationship between patient panel characteristics and relative physician clinical performance rankings within a large academic primary care network.

Design, Setting, and Participants  Cohort study using data from 125,303 adult patients who had visited any of the 9 hospital-affiliated practices or 4 community health centers between January 1, 2003, and December 31, 2005, (162 primary care physicians in 1 physician organization linked by a common electronic medical record system in Eastern Massachusetts) to determine changes in physician quality ranking based on an aggregate of Health Plan Employer and Data Information Set (HEDIS) measures after adjusting for practice site, visit frequency, and patient panel characteristics.

Main Outcome Measures  Composite physician clinical performance score based on 9 HEDIS quality measures (reported by percentile, with lower scores indicating higher quality).

Results  Patients of primary care physicians in the top quality performance tertile compared with patients of primary care physicians in the bottom quality tertile were older (51.1 years [95% confidence interval {CI}, 49.6-52.6 years] vs 46.6 years [95% CI, 43.8-49.5 years], respectively; *P* < .001), had a higher number of comorbidities (0.91 [95% CI, 0.83-0.98] vs 0.80 [95% CI, 0.66-0.95]; *P* = .008), and made more frequent primary care practice visits (71.0% [95% CI, 68.5%-73.5%] vs 61.8% [95% CI, 57.3%-66.3%] with >3 visits/year; *P* = .003). Top tertile primary care physicians compared with the bottom tertile physicians had fewer minority patients (13.7% [95% CI, 10.6%-16.7%] vs 25.6% [95% CI, 20.2%-31.1%], respectively; *P* < .001), non–English-speaking patients (3.2% [95% CI, 0.7%-5.6%] vs 10.2% [95% CI, 5.5%-14.9%]; *P* < .001), and patients with Medicaid coverage or without insurance (9.6% [95% CI, 7.5%-11.7%] vs 17.2% [95% CI, 13.5%-21.0%]; *P* < .001). After accounting for practice site and visit frequency differences, adjusting for patient panel factors resulted in a relative mean change in physician rankings of 7.6 percentiles (95% CI, 6.6-8.7 percentiles) per primary care physician, with more than one-third (36%) of primary care physicians (59/162) reclassified into different quality tertiles.

Conclusion  Among primary care physicians practicing within the same large academic primary care system, patient panels with greater proportions of underinsured, minority, and non–English-speaking patients were associated with lower quality rankings for primary care physicians.

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We tested the hypothesis that a physician’s patient panel characteristics are independently associated with changes in his or her relative quality ranking. We ranked all primary care physicians within a single, academic primary care network according to a composite of commonly used Health Plan Employer and Data Information Set (HEDIS) measures and (1) compared patient panel characteristics of highest vs lowest ranked physicians, (2) examined changes in primary care physician rankings after adjusting for differences in patient panel characteristics, and (3) compared the patient panel characteristics of primary care physicians who moved up or down in their quality rankings.

METHODS
We conducted a cohort analysis to study the relationship between patient panel characteristics and physician clinical performance. The Massachusetts General Hospital Practice–based research network includes 181 primary care physicians working in 9 hospital-affiliated practices and 4 community health centers. All practices use the same electronic billing and scheduling systems and share an advanced electronic medical record system. Physicians are hired and credentialed using similar criteria, share the same compensation plan, and have similar staffing resources.

We identified 164,283 adult patients who visited any Massachusetts General Hospital Practice–based research network primary care practice from January 1, 2003, to December 31, 2005, using electronic billing records and excluding those who died (n = 2,281). We matched 124,419 of the group data. We matched 2,281 of the patient’s US Census block group. We matched addresses using StreetMap Premium software (Esri, Redlands, California), obtained geographic information system coordinates from successfully matched addresses using ArcGIS software (Esri), and input these geographic information system coordinates into the Demographic Update (Esri) to obtain 2007 US Census block group data. We matched 124,419 of the addresses (99.3%) with 80% sensitivity (requiring 80% of the characters to match identically) and an additional 838 using lower sensitivity limits (0.6%), leaving 46 unmatched (0.4%).

We calculated physician composite quality scores based on 9 HEDIS measures including (1) mammography in the previous 2 years for eligible women aged 42 to 69 years; (2) Pap test cervical screening in the previous 3 years for eligible women aged 21 to 64 years; (3) colorectal cancer screening within 10 years, sigmoidoscopy or double-contrast barium enema within 5 years, or home fecal occult blood testing within 1 year for eligible patients aged 52 to 69 years; (4) hemoglobin A1c testing in the prior year and proportion with levels of 7.0% or less in patients with diabetes; (5) low-density lipoprotein cholesterol testing in the previous year and proportion with levels of 100 mg/dL or less (to convert to mmol/L, multiply by 0.0259) for patients with diabetes and coronary artery disease.

To create the composite physician quality score, we first ranked primary care physicians for each of the 9 measures based on the log odds of achieving the performance measure using multilevel logistic regression models. This accounted for both clustering of patients within primary care physicians and for heteroscedasticity produced by the varying number of quality measurements for each primary care physician. We ranked primary care physicians after each of the 3 following stages of adjustment. Model 1 was unadjusted, model 2 was adjusted for practice and visit frequency, and model 3 was adjusted for practice, visit frequency, and all patient panel variables (patient age, sex, number of comorbidities, race/ethnicity, primary language spoken, and insurance status). In model 2, we first adjusted for primary care physician practice site to account for unmeasured practice characteristics and number of practice visits to allow for fairer assessment of primary care physician quality by adjusting for differences in direct patient contact (and therefore differences in direct opportunities to order the indicated tests or make appropriate management changes to achieve optimal hemoglobin A1c or low-density lipoprotein cholesterol control). Geo-coded variables for median household income and high school graduation rates were excluded in the final model because of minimal additional effect after adjustment for patient-level variables (mean change in primary care physician ranking of 1.9 percentiles).

We calculated physician composite rankings at each stage of adjustment as
the average of all individual scores for each of the 9 available HEDIS measures. The final composite score was converted to percentiles (range 1-100) with a lower percentile indicating higher primary care physician quality ranking. Each primary care physician thus had a composite quality score after each of the 3 stages of adjustment.

Using unadjusted composite quality scores (model 1), we compared physician and patient panel characteristics between physicians ranked in the top vs bottom quality tertile using the χ² test, the Wilcoxon rank sum test, or the t test. Then, we examined changes in relative physician rankings from the unadjusted base model (model 1) attributable to patient panel differences (model 3). All variables except for the intercept were considered as fixed effects in the multilevel regression analysis.

At each stage of adjustment, we identified physicians with a greater than 5 and 10 percentile absolute change in their relative composite quality ranking. Because many performance incentive programs focus on tiers of physician quality, we also divided the 162 primary care physicians into tertiles based on their unadjusted composite quality rankings and assessed for reclassification into different postadjustment tertiles. We chose to classify physicians by tertiles because division into 3 quality categories is more intuitive than 2, and because it decreases the opportunity for misclassification, thus serving as a conservative classification approach. Finally, among the subset of physicians with a greater than 10 percentile change in their relative composite quality rankings from model 1 (unadjusted) to model 3 (fully adjusted), we used χ², Wilcoxon rank sum, and t tests to compare the physician and patient panel characteristics of physicians who went up vs down in their composite quality rankings.

We used a threshold P value of less than .05 to determine statistical significance. Data were missing for less than 1.8% of all variables, and we performed a complete case analysis. We used SAS statistical software version 9.1.3 (SAS Institute Inc, Cary, North Carolina) for all analyses except for multilevel models that were estimated using MLwiN multilevel modeling software version 2.11 (Centre for Multilevel Modelling, London, England). The Massachusetts General Hospital institutional review board approved the study.

## RESULTS

The 162 primary care physicians eligible for analysis were a mean of 18.6 years (95% confidence interval [CI], 16.9-20.2 years) from medical school graduation (TABLE 1). Fewer top tertile compared with bottom tertile primary care physicians practiced in community health centers (17.0% [95% CI, 6.9%-27.1%] vs 47.2% [95% CI, 33.7%-60.6%], respectively; P = .001). A greater proportion of female compared with male primary care physicians were in the top tertile of unadjusted primary care physician composite ranking (62.3% [95% CI, 49.2%-75.3%] vs 34.0% [95% CI, 21.2%-46.7%], respec-

### Table 1. Primary Care Physician (PCP) and Patient Characteristics

<table>
<thead>
<tr>
<th>PCPs Overall (N=162)</th>
<th>PCPs by Unadjusted Composite Quality Score Tertile</th>
<th>P Value&lt;sup&gt;b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (95% CI)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Top (n=53)</td>
</tr>
<tr>
<td>Composite score percentile&lt;sup&gt;c&lt;/sup&gt;</td>
<td>50.5 (46.0-55.0)</td>
<td>17.1 (14.4-19.7)</td>
</tr>
<tr>
<td>Period since medical school graduation, y</td>
<td>18.6 (16.9-20.2)</td>
<td>18.8 (16.3-21.3)</td>
</tr>
<tr>
<td>Community health center practiced&lt;sup&gt;d&lt;/sup&gt;</td>
<td>48 (29.6) [22.6-36.7]</td>
<td>9 (17.0) [6.9-27.1]</td>
</tr>
<tr>
<td>Female sex&lt;sup&gt;d&lt;/sup&gt;</td>
<td>79 (48.8) [41.1-56.5]</td>
<td>33 (62.3) [49.2-75.3]</td>
</tr>
<tr>
<td>Patient panel size</td>
<td>773 (706-841)</td>
<td>746 (631-861)</td>
</tr>
</tbody>
</table>

**Patients (n = 125 303)**

|                       | Mean (95% CI)<sup>a</sup>                        | Top (n=53)       | Bottom (n=53) |
|-----------------------|--------------------------------------------------|-------------------|
| Panel age, y | 49.2 (47.9-50.4) | 51.1 (49.6-52.6) | 46.6 (43.8-49.5) | <.001 |
| No. of comorbidities | 0.85 (0.79-0.91) | 0.91 (0.83-0.98) | 0.80 (0.66-0.96) | .008 |
| Female sex, % | 40.3 (36.6-44.0) | 34.2 (27.6-40.8) | 47.5 (42.0-53.0) | .002 |
| Minority race/ethnicity, % | 19.2 (16.7-21.7) | 13.7 (10.6-16.7) | 25.6 (20.2-31.1) | <.001 |
| Non-English-speaking, % | 6.3 (4.3-8.3) | 3.2 (0.7-5.6) | 10.2 (5.5-14.9) | <.001 |
| Privately insured, % | 69.7 (67.2-72.3) | 72.4 (69.5-75.3) | 66.0 (60.4-71.6) | .25 |
| Medicare, % | 17.5 (15.4-19.6) | 18.0 (16.0-20.1) | 16.7 (11.7-21.7) | .009 |
| Medicaid or uninsured, %<sup>d</sup> | 12.8 (11.0-14.5) | 9.6 (7.5-11.7) | 17.2 (13.5-21.0) | <.001 |
| High school graduate, %<sup>e</sup> | 85.7 (84.5-86.9) | 87.9 (86.5-89.4) | 82.7 (80.3-85.1) | <.001 |
| Family household income in US $<sup>d</sup> | 60 155 (58 178-62 131) | 63 901 (61 118-66 684) | 53 890 (50 518-57 261) | <.001 |

<sup>a</sup>Abbreviation: CI, confidence interval.

<sup>b</sup>Unless otherwise indicated.

<sup>c</sup>Calculated using the χ² test, the Wilcoxon rank sum test, or the t test.

<sup>d</sup>Based on 9 Healthcare Effectiveness Data and Information Set measures. All PCPs were ranked and given percentile scores (a lower score indicates higher overall quality).

<sup>e</sup>Values are expressed as number (percentage) [95% CI].

<sup>f</sup>Based on 2007 US Census block group data.

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PHYSICIAN CLINICAL PERFORMANCE RANKINGS

Table 2. Changes in Primary Care Physician (PCP) Rankings on Composite Quality Scores

<table>
<thead>
<tr>
<th>Change in PCP rankings, mean percentile (95% CI)</th>
<th>Model 2a</th>
<th>Model 3b</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCPs with change in rankings, No. (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;5 percentiles</td>
<td>122 (75.9)</td>
<td>95 (58.6)</td>
</tr>
<tr>
<td>&gt;10 percentiles</td>
<td>86 (53.1)</td>
<td>52 (32.1)</td>
</tr>
</tbody>
</table>

Abbreviation: CI, confidence interval.

aAdjusted for practice and visit frequency.
bAdditionally adjusted for age, sex, comorbidity, race/ethnicity, language, and insurance status.

Figure. Absolute Ranking Change for Primary Care Physicians From Practice- and Visit Frequency-Adjusted Model After Additional Adjustment for Patient Panel Characteristics

![Figure](image)

Adjustment for practice and visit frequency (model 2) led to marked changes in relative physician quality rankings with more than 75% of primary care physicians changing by more than 5 percentiles and more than half of primary care physicians changing by more than 10 percentiles following adjustment (Table 2). Physician rankings changed by an average of 15.1 percentiles (95% CI, 12.9-17.3 percentiles) following adjustment for practice and visit frequency.

Adjustment for patient panel characteristics led to further re-ranking of primary care physicians, with 58.6% of primary care physicians changing more than 5 percentiles and 32.1% changing more than 10 percentiles. The mean change in physician rankings attributable to further adjustment for patient characteristics was 7.6 percentiles (95% CI 6.6-8.7 percentiles). The figure shows the distribution of absolute changes in rank among primary care physicians following this adjustment.

When comparing the fully adjusted model (model 3) with the model adjusted for practice and visit frequency (model 2), 11.3% of primary care physicians originally in the top composite score tertile decreased in ranking to the middle tertile, 14.3% of bottom tertile primary care physicians increased in ranking to the middle tertile, and 25.0% of middle tertile primary care physicians moved into the top or bottom tertile (Table 3).

The 34 primary care physicians whose relative quality rankings increased by more than 10 percentiles after adjustment were more likely to be physicians practicing at community health centers and have larger overall panel sizes. These physicians were also more likely to have panels with a higher proportion of minority, non–English-speaking, and younger patients with fewer comorbidities compared with the 44 primary care physicians whose relative quality rankings decreased after adjustment (Table 4).

COMMENT

We examined relative physician quality rankings using an aggregate of commonly used HEDIS measures in a cohort of primary care physicians working within a single integrated health system. Primary care physicians in the top tertile of measured quality were more likely to care for older patients with greater comorbidity who made more frequent visits to see a primary care physician. This finding is consistent with prior studies. Because older patients with more comorbidities are often seen more frequently, they may have stronger relationships with their physicians, and physicians caring for such patients may have more opportunities to complete process measures. Also, in concordance with literature in health care disparities, top tertile primary care physicians were less likely to care for minority, non–English-speaking, Medicaid, and uninsured patients compared with bottom tertile primary care physicians.

After accounting for practice site and visit frequency differences, adjusting for patient panel factors resulted in an additional relative mean rank change of...
7.6 percentiles (95% CI, 6.6-8.7 percentiles) in physician quality rankings. Our research expands on prior studies demonstrating the effect of patient case-mix on hospital-level quality.\textsuperscript{21,22} As seen in these studies, the magnitude of the change in physician rankings in our study was moderate for most primary care physicians and large for few; however, even modest changes in rankings have important consequences for physician reclassification between fixed thresholds (such as those often used in performance incentive programs and quality reporting). These changes in ranking after adjustment resulted in the reclassification of 36% of primary care physicians (59/162) into different tertiles of composite quality score.

Moreover, primary care physicians whose ranking increased by greater than 10 percentiles after adjustment were more likely to work in community health centers and care for a higher proportion of minority and non–English-speaking patients. Therefore, one potential risk of not adjusting for patient panel makeup is undervalued quality ranking for primary care physicians who work in community health centers or those who take care of minority and non–English-speaking patients. This illustrates one potential unintended consequence of current (ie, not adjusted for patient panel) physician clinical performance assessment when tied to performance-based incentives.

Our findings provide evidence of the effect of patient panel makeup on attainment of HEDIS quality measures and support our hypothesis that patient panel characteristics are associated with changes in relative physician quality scores. Furthermore, our study demonstrates possible effects of this finding on misclassification of physicians when ranking or tiers are used to compare physician quality and reveals a potential mechanism for unintended consequences posed by physician clinical performance assessment in the setting of performance incentive programs.

These results have considerable policy implications given the increasing role of physician performance incentive programs.\textsuperscript{6} Prior studies have posited numerous potential unintended consequences of these programs.\textsuperscript{22-27} Our study demonstrates a potential mechanism through which performance incentive programs might worsen health care disparities. Because physicians and practices with higher quality scores receive higher payments and recognition under these programs, these incentive approaches could erroneously distribute resources away from high-quality physicians caring for more vulnerable patients and worsen health care disparities.\textsuperscript{6,23,26}

Additionally, prior studies by our group demonstrate that socioeconomically deprived patients are less likely to be connected to their physicians and make fewer visits to their primary care physicians.\textsuperscript{9} These practice-connected rather than primary care physician–connected patients were more likely to be found in community health centers.\textsuperscript{9} Beyond issues surrounding patient attribution, decreased connectedness to physicians could exacerbate the

### Table 3. Changes in Primary Care Physician (PCP) Composite Score Tertile

<table>
<thead>
<tr>
<th>Initial Tertile</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (n=53)</td>
<td>47 (78.7)</td>
<td>6 (11.3)</td>
<td>0</td>
</tr>
<tr>
<td>2 (n=56)</td>
<td>6 (10.7)</td>
<td>42 (75.0)</td>
<td>8 (14.3)</td>
</tr>
<tr>
<td>3 (n=53)</td>
<td>0</td>
<td>8 (14.3)</td>
<td>45 (84.9)</td>
</tr>
</tbody>
</table>

*Adjusted for practice and visit frequency (model 2).*
*Additionally adjusted for patient age, sex, comorbidity, race/ethnicity, language, and insurance status (model 3).*

<table>
<thead>
<tr>
<th>Percentile Change in PCP Ranking, Mean (95% CI)</th>
<th>&gt;10 Increase (n=34)</th>
<th>&gt;10 Decrease (n=44)</th>
<th>(P) Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physicians Composite score percentile</td>
<td>64.3 (55.8-72.8)</td>
<td>43.6 (37.3-49.9)</td>
<td>.001</td>
</tr>
<tr>
<td>Period since medical school graduation, y</td>
<td>16.1 (12.5-19.7)</td>
<td>20.7 (17.0-24.3)</td>
<td>.08</td>
</tr>
<tr>
<td>Community health center practice</td>
<td>16 (47.1) [30.3-63.8]</td>
<td>9 (20.5) [8.5-32.4]</td>
<td>.01</td>
</tr>
<tr>
<td>Female sex</td>
<td>20 (58.8) [42.3-75.4]</td>
<td>15 (34.1) [21.0-48.1]</td>
<td>.03</td>
</tr>
<tr>
<td>Patient panel size</td>
<td>946 (804-1088)</td>
<td>740 (609-870)</td>
<td>.02</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Abbreviation: CI, confidence interval.</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Unless otherwise indicated.</em></td>
</tr>
<tr>
<td>*<em>Calculated using the (z) test, the Wilcoxon rank sum test, or the (t) test.</em></td>
</tr>
<tr>
<td><strong>Based on 9 Healthcare Effectiveness Data and Information Set measures. All PCPs were ranked and given percentile scores (a lower score indicates higher overall quality).</strong></td>
</tr>
<tr>
<td><strong>Values are expressed as number (percentage) [95% CI].</strong></td>
</tr>
<tr>
<td><strong>Based on 2007 US Census block group data.</strong></td>
</tr>
</tbody>
</table>
the target of performance incentive pressure that disparities in care are made performance with vulnerable patients and en-
curages and practices for lower perfor-
manship to improve care or may in-
crease the number of patients to be included, and mini-
izes the influence of any single measure–specific outcome. The compositing method used in our study allows for easy addition of mea-
ures as well as transparent weighting when necessary. However, despite the advantages of such composite quality measures, few quality measurement tools incorporate other dimensions of clinical quality (eg, physician empa-
athy and communication skills), and it remains important to continue evalu-
ating physician clinical performance on individual measures because qual-
ity improvement is more easily tar-
ged at specific outcomes and because one measure may not predict performance on others.

We must interpret our results within the context of the study design. While it is a strength to compare the associa-
tion of patient characteristics on clinical performance measures among a rela-
tively homogenous physician cohort, our results may not be generalizable to other health care systems such as com-
nunity health systems or smaller pri-
ivate practice networks that makeup the majority of health care delivery in the United States. In addition, use of cur-
rently available quality measures that are not comprehensive, are process-
oriented, and may not measure actual physician quality has limitations. None-
theless, because these HEDIS-based measures are widely used, our find-
ings remain directly applicable to cur-
rent quality measurement practices. An-
other consideration is that quality estimates for some physicians may be more reliable for one measure than an-
other. Although we addressed heterogeneity in sample sizes between physicians using multilevel modeling techniques, this continues to be a cen-
tral hurdle for physician-level clinical performance measures. Finally, al-
though adjustment for patient vari-
ables in this study may have contribu-
ted to a more accurate estimation of quality outcomes, they only account for a fraction of the total variability in phy-
sician-level quality scores. Additional work is necessary to develop a wider range of reliable patient-, physician-, and practice-level variables.

In summary, our study demonstrates that patient panel characteristics are associated with the relative mea-
sured quality of physicians within a large academic primary care network. Adjustment for differences in patient panel characteristics resulted in signifi-
cant reclassification of top tier vs bot-
tom tier physicians. To the extent that health systems reward physicians for higher measured quality of care, lack of adjustment for patient panel character-
istics may penalize physicians for taking care of more vulnerable pa-
ients, incentivize physicians to select patients to improve their quality scores, and result in the misallocation of re-
sources away from physicians taking care of more vulnerable populations. Conversely, adjustment for patient panel characteristics may remove the incentive to improve care or may in-
appropriately reward lower-quality phy-
sicians caring for more vulnerable pa-
ients. Efforts to improve quality of care must address both fairness of phy-
sician clinical performance assessment and the design of incentive schemes to both provide equitable distribution of resources and reduce disparities in care for vulnerable patients.

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chusetts; and General Medicine Division, Massachu-
setts General Hospital, Boston (Drs Hong, Atlas, Chang, Barry, and Grant, and Mr Ashburner).

**Author Contributions:** Dr Hong had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

**Study concept and design:** Hong, Atlas, Chang, Subramanian, Barry, Grant.

**Acquisition of data:** Hong, Atlas, Ashburner.
Analysis and interpretation of data: Hong, Atlas, Chang, Subramanian, Ashburner, Grant. Drafting of the manuscript: Hong, Grant.

Critical revision of the manuscript for important intellectual content: Hong, Atlas, Chang, Subramanian, Ashburner, Barry, Grant.

Statistical analysis: Hong, Chang, Subramanian, Ashburner.

Obtained funding: Grant.

Administrative, technical, or material support: Hong, Atlas, Subramanian.

Study supervision: Atlas, Subramanian, Grant.

Financial Disclosures: None reported.

REFERENCES


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