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Achieving Equity in Hospital Performance Assessments using Composite Race-Specific Measures of Risk Standardized Readmission and Mortality Rates for Heart Failure

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Abstract

Background: The contemporary measures of hospital performance for heart failure (HF) hospitalization —30-day risk-standardized readmission (RSRR) and mortality rate (RSMR) —are estimated using the same risk adjustment model and overall event rate for all patients. Thus, these measures are mainly driven by the care quality and outcomes for the majority racial/ethnic group and may not adequately represent the hospital performance for patients of Black and other races.

Methods: Fee-for-service Medicare beneficiaries from 1/2014–12/2019 hospitalized with HF were identified. Hospital-level 30-day RSRR and RSMR were estimated using the traditional race-agnostic models and the *race-specific* approach. The composite *race-specific* performance metric was calculated as the average of the RSRR/RMSR measures derived separately for each race/ethnicity group. Correlation and concordance in hospital performance for all patients and patients of Black and other races was assessed using the composite *race-specific* and race-agnostic metrics.

Results: The study included 1,903,232 patients (White patients = 75.7% [N=1,439,958], Black patients = 14.5% [N=276,684], patients of other races = 9.8% [N=186,590]) with HF from 1860

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hospitals. There was a modest correlation between hospital-level 30-day performance metrics for patients of White vs. Black race (r_c: RSRR= 0.42, RSMR=0.26). Compared with the race-agnostic RSRR and RSMR, composite race-specific metrics for all patients demonstrated stronger correlation with RSRR (r_c: 0.60 vs. 0.74) and RSMR (r_c: 0.44 vs. 0.51) for Black patients. Concordance in hospital performance for all patients and patients of Black race was also higher with race-specific (vs. race-agnostic) RSRR (64% vs. 53% concordantly high-performing; 61% vs. 51% concordantly low-performing). Race-specific RSRR and RSMR metrics (vs. race-agnostic) led to reclassification in performance ranking of 35.8% and 39.2% of hospitals respectively with better 30-day and 1-year outcomes for patients of all race groups at hospitals reclassified as high-performing.

Conclusion: Among patients hospitalized with HF, race-specific 30-day RSMR and RSRR are more equitable in representing hospital performance for patients of Black and other races.

Keywords

Disparities; Health Policy; Heart Failure; Readmission; Mortality; Outcomes

INTRODUCTION

Heart Failure (HF) hospitalizations have been a target of health policymakers to improve care quality and outcomes and reduce expenditures. In 2005, the Centers for Medicare and Medicaid Services (CMS) began publicly reporting 30-day risk-standardized readmission rates (RSRR) and mortality rates (RSMR) for HF as hospital performance metrics. Subsequently, the Value-Based Purchasing Program (VBPP) and the Hospital Readmissions Reduction Program (HRRP) were implemented to provide financial incentives to hospitals based on performance in the readmission and mortality metrics.[1]

The optimal performance metric should accurately represent hospital care quality fairly across diverse patient populations. Furthermore, comparisons in hospital performance should account for differences in patient-level factors, including disease severity and social determinants of health (SDOH). There are significant, longstanding persistent disparities in HF between White patients and patients of minoritized race groups.[2,3] Patients of self-reported Black race face different drivers of poor outcomes post-hospitalization as compared with White patients.[4] Much of the difference in outcomes between Black (vs White) adults are due to educational and economic racial inequities. Black adults live in higher-poverty areas with fewer opportunities and access to health care. [5–9]

The current CMS methodology estimates 30-day RSRR and RSMR accounting for heterogeneity in disease severity across hospitals by adjusting for patient-level case mix. However, the current approach uses the same risk-adjustment model and observed event rate for all patients with a specific condition to estimate the 30-day RSMR and RSMR without accounting for race or socioeconomic status differences. Thus, although the 30-day performance metrics capture hospital quality for all patients with HF, the metrics are primarily driven by the performance of the majority racial/ethnic group. It is unclear whether these metrics adequately reflect quality for patients of minoritized race groups with a smaller contribution to the hospital mortality or readmission rate.

To address this knowledge gap, we developed a novel approach to evaluate hospital performance among hospitalized patients with HF using *race-specific* RSRR and RSMR metrics. While there are no established gold standards, we assessed equity in performance metrics based on how well the hospital-level performance metric captures the hospital's performance for patients of Black and other race/ethnic group. We hypothesized that a composite race-specific RSRR and RSMR (vs. currently used race-agnostic metrics) for all patients would better account for the differential outcomes and contributions to mortality risk unique to different race/ethnicity groups and be more equitable in assessing hospital performance.

METHODS

Data used for the study are covered under a data use agreement with the CMS and are not available for distribution by the authors but may be obtained from CMS with an approved data use agreement.

Study cohort

All patients admitted with a primary diagnosis of heart failure (HF) from 01/01/2014 to 12/01/2019 were identified from the Medicare Provider Analysis and Review (MedPAR) 100% files using International Classification of Diseases (ICD) Version 9 Codes (428.*, 402.01, 402.11, 402.91, 404.01, 404.11, 404.91, 404.03, 404.13, 404.93) and Version 10 Codes (I50.*, I11.0, I13.0, I13.2). ICD codes for right-sided HF or high output HF were excluded. Only the first admission was considered for analysis for patients with more than one hospitalization. Exclusion criteria for the study were age < 65 years, less than one year of coverage before the HF admission date, discharge on the same day of admission, discharge to hospice or against medical advice, and use of palliative care within 30 days before the HF admission date. All ICD codes submitted in claims for one year before the HF index admission were mapped to conditions and comorbidities using published CMS risk models and a validated claims-based "Hospital Frailty Risk Score."[10] Patient demographics (age, sex, race and ethnicity) and enrollment dates were extracted from Medicare Beneficiary Summary Files. The "Research Triangle Institute Race Code" variable was used for race and ethnicity, which was validated in prior studies against self-identified race and ethnicity with a specificity of >95%.[11] This variable has five categories; Non-Hispanic White, Non-Hispanic Black, Hispanic, Asian/Pacific Islander, and Native American, and these categories are mutually exclusive. Patients in our study cohort were divided into three groups: 1) White patients, 2) Black patients, and 3) patients of other races/ethnicities, including Hispanic, Asian/Pacific Islander, and Native American. Hospitals that treated <30 patients of a specific race/ethnicity group with HF were excluded from analysis. We also excluded hospitals that treated one race/ethnicity exclusively (for example, hospitals that treated only White patients). Safety-net hospitals were determined using the CMS publicly available "Impact File" for the year 2013 as hospitals that are in the highest quartile for the "Disproportionate Share Hospital (DSH) Index".[12] The proportion of dual-eligible HF patients for Medicaid and Medicare treated in each study hospital was calculated, and hospitals in the top quartile were deemed high Medicaid hospitals. Hospital characteristics, including teaching affiliation, number of beds, rural/urban location, ownership model, and

census region location, were determined from the American Hospital Association File. The Institutional Review Board of the Cleveland Clinic approved the study with a waiver of informed consent.

Outcomes of interest

The study outcomes were hospital-level 30-day RSRR and RSMR. Consistent with prior approaches, 30-day mortality was calculated from the date of HF admission and included patients who died in the hospital. 30-day readmission was calculated from the discharge date during index HF admission and included all admissions to a short-term, acute care hospital.

Estimation of 30-day RSRR and RSMR using race-agnostic and race-specific approaches

Hospital-level performance metrics of 30-day RSRR and RSMR were estimated using two distinct approaches. The first approach—the *race-agnostic metric*—was consistent with the CMS methodology and included estimation of 30-day outcomes using a common risk adjustment model for all HF patients without factoring patient's race/ethnicity.[13,14] The second approach—*the composite race-specific metric*—included the development of separate risk adjustment models for three race/ethnicity groups (Black, White, and other races/ethnicities) and estimation of hospital-level 30-day outcomes for each race/ethnicity group.

Risk adjustment models for 30-day RSRR estimation were developed for all HF patients and each race/ethnicity group separately using the previously described approach.[15] First, hierarchical logistic mixed models were used to calculate risk-adjusted 30-day readmission to account for differences in case-mix across hospitals for each cohort of interest (all HF patients and each race/ethnicity group). Candidate variables for risk adjustment included patients' age, sex, and the 259 chronic conditions defined using published CMS risk software/models, cardiac conditions defined by ICD codes, components of a prior validated claims-based "Hospital Frailty Risk Score" and individual components of neighborhood level measure of social determinants of health (SDOH): social deprivation index (SDI) and distressed community index (DCI) (Table-S1).[10,16] Each cohort of interest was divided into two halves— a derivation and a validation cohort. The risk adjustment models were constructed using a logit link and binomial distribution and estimated using maximum likelihood with 30-day readmission as the outcome, patient-level variables as fixed effects, and the hospital as a random effect. These models were performed on 100 bootstrap samples from the derivation cohort, and candidate variables that were significant (P-value <0.01) in >80% of the models remained in the final clinical risk adjustment model. Subsequently, Zip code level SDI and DCI variables were added to the final clinical model with 100 bootstrap samples from the cohort. Zip code variables that were significant with a P-value <0.01 in >50% of the models remained in the final risk adjustment model. After determining the final model, expected and predicted mortality was calculated with and without linear unbiased prediction modeling to estimate random effects, similar to the CMS approach. The model fit statistics (C-statistics, Akaike, Bayesian, Hannan & Quinn information criterion AIC, BIC, HQIC]) for the final risk adjustment models (composite race-specific and race-agnostic) were calculated in the validation and derivation cohorts. The final risk adjustment models for 30-day RSRR for each race/ethnicity group and the race-agnostic approach in all patients

are shown in Tables-S2,S3. A similar methodology was used to develop 30-day RSMR risk adjustment models. Final risk adjustment models for 30-day RSMR for each race/ethnicity group and the race-agnostic approach in all patients are shown in Tables-S4,S5.

The final race-agnostic 30-day RSRR and RSMR for each hospital were calculated by multiplying the predicted/expected readmission or mortality ratio derived from the race-agnostic model by overall crude readmission or mortality rate for the overall cohort. The race-specific 30-day RSRR and RSMR were calculated by multiplying the predicted/expected mortality ratio for each race/ethnicity group with its corresponding race-specific crude readmission or mortality rate for the overall cohort, respectively. Finally, the composite race-specific 30-day RSRR or RSMR for each hospital was estimated by averaging the three race-specific measures (Example: (White 30-day RSRR+ Black 30-day RSRR + other races 30-day RSRR)/3). The RSMR/RSRR for each race/ethnicity group was weighted equally so that the composite performance metric allows for equal representation of each race/ethnicity group specific outcome in the overall performance metric of the hospital.

Statistical analysis

Hospitals were ranked by 30-day RSRR and RSMR for all patients using the composite race-specific and race-agnostic metrics. Hospital characteristics were reported across the quartiles as median (25^{th} and 75^{th} percentile) for continuous variables and proportion for categorical variables and compared using the Kruskal-Wallis test for continuous variables and the Chi-square test for categorical variables. Patient characteristics were reported across the quartiles as the median (25^{th} and 75^{th} percentile) of the hospital-level proportions of patients (for categorical variables) and hospital-level means (for continuous variables) and compared using the Kruskal-Wallis test.

Correlation between hospital-level race-specific measures of 30-day RSRR and RSMR for White patients vs. other race/ethnicity groups (White vs. Black and White vs. other race groups) was assessed using the Pearson correlation coefficient (r_c). Hospitals were ranked into quartiles (Q1- high performing, Q4- low performing) based on 30-day RSRR and RSMR for all patients (using both approaches) and for each race/ethnicity group. Correlation and concordance in hospital performance ranking by 30-day RSRR and RSMR for all patients (assessed by race-agnostic and the race-specific approach) vs. Black patients and patients of other races (only correlation) were also evaluated. Reclassification of hospital performance for all patients based on race-specific RSRR and RSMR (vs. race-agnostic metrics) was also assessed. For this analysis, hospitals that improved or worsened their performance ranking by at least one quartile based on the composite race-specific and race-agnostic measures were deemed up classified or down classified, respectively. Patient-level 30-day and 1-year readmission rates and mortality rates for each race/ethnicity group were compared between hospitals that changed rank vs. hospitals that did not change rank.

Sensitivity Analyses—Several sensitivity analyses were performed to assess the robustness of the study findings. First, correlation and concordance in the performance of race-agnostic and race-specific 30-day RSRR and RSMR for all patients vs. patients of

Black race and other races were assessed across hospital subgroups stratified by safety-net status (yes vs. no) and by the proportion of dual coverage (Medicare + Medicaid) eligible patients (high [quartile 4] vs. not high [quartile 1–3]). Second, sensitivity analyses were performed using the current CMS risk adjustment models for estimating race-agnostic and composite race-specific (using the same risk adjustment for each race group) 30-day RSMR and RSRR.[13,14] For this, published CMS risk-standardization variables were utilized for the overall patient population (for race-agnostic approach) and each race group (for the composite race-specific approach). Third, as an alternative to the equally weighted composite race-specific metrics, *proportionally-weighted* race-specific 30-day RSRR and RSMR were also estimated based on the hospital-level case proportion of each race group. The analysis was performed using SAS version 9.4 (SAS Institute, Inc., Cary, North Carolina) and GraphPad Prism version 8.

RESULTS

The final study cohort included 1,903,232 patients (White patients = 75.7% [N=1,439,958], Black patients = 14.5% [N=276,684], patients of other races = 9.8% [N=186,590]) from 1860 hospitals (781 hospitals treated patients from all three groups, 654 hospitals treated only patients of White and Black race, 406 hospitals treated only patients of White and other races, and 19 hospitals treated patients only of Black and other races) (Figure-S1). The other race group included patients of Asian/Pacific Islander (2.2%), Hispanic (7.2%), and Native American (0.4%) race/ethnicity. At the hospital level, median percentage (25^{th}-75^{th} range) of self-reported White and Black race patients were 77.8% (60.6–89.2) and 10.4% (2.9–23.8) respectively. 1564 (84.1%) hospitals treated majority White patients (>50% of its patients), and 118 hospitals (6.3%) treated majority Black patients. The race-specific risk-standardized models for readmission and mortality demonstrated superior fit and similar model performance for all race/ethnicity groups compared to race-agnostic risk-adjustment models (Table-S6).

There was a modest correlation between hospital-level 30-day RSRR for White patients vs. Black patients (r_c = 0.42, Figure-1) and a poor correlation between hospital-level 30-day RSMR for White patients vs. Black patients (r_c = 0.26, Figure-1). Similar findings were observed for the correlation between 30-day RSRR/RSMR for White patients vs. those of other races (Figure-S2).

Hospital and patient characteristics across race-specific 30-day RSRR and RSMR groups

High-performing hospitals based on the composite race-specific RSRR were larger, more likely to be academic, and less likely to be rurally located, considered safety net hospitals, or care for a higher proportion of patients with dual coverage (Table-1). Findings were similar at the hospital level across the composite race-specific RSMR categories (Table-1). Among patient characteristics, high-performing hospitals based on composite race-specific RSRR had a greater proportion of White patients and patients of other races and less Black patients (Table-S7). The prevalence of comorbid conditions was relatively similar across quartiles of composite race-specific RSRR. In contrast, based on the composite race-specific

RSMR metric, high-performing hospitals had a greater proportion of patients of other races (Table-S8).

Performance of the composite race-specific vs. race-agnostic metrics for all HF patients across different race/ethnicity groups

The race-agnostic RSRR for all patients was correlated to the RSRR for Black patients (r_c = 0.60, Figure-2) and for patients of other races (r_c = 0.58, Figure-S3). The composite race-specific RSRR demonstrated a stronger correlation with RSRR for Black patients (race-specific: r_c = 0.74, p-value for difference in correlation <0.001, Figure-2) and for patients of other races (r_c =0.73, p <0.001, Figure-S3). Similarly, composite race-specific (vs. race-agnostic) RSMR for all patients had a stronger correlation with 30-day RSMR for Black patients (race-specific: r_c = 0.51 vs. race-agnostic r_c = 0.44, p = 0.01, Figure-3) but comparable correlation for patients of other races (race-specific: r_c = 0.50; race-agnostic: r_c = 0.49, p = 0.5, Figure-S3). The correlation of performance measures (RSRR and RSMR) for all patients with the corresponding measures for White patients was very high using both race-specific and race-agnostic approaches (race-specific vs. race-agnostic RSRR: r_c = 0.88 vs. 0.85, p<0.001, Figure-2; race-specific vs. race-agnostic RSMR: r_c = 0.84 vs. 0.90, p<0.001 for both, Figure-3).

Concordance in hospital performance for all patients vs. Black patients using composite race-specific and race-agnostic metrics

53% of high-performing hospitals and 51% of low-performing hospitals based on race-agnostic 30-day RSRR for all patients were concordantly high and low performing for Black patients (Table-2). Composite race-specific RSRR was associated with greater concordance in hospital performance between all patients and Black patients (64% concordantly high-performing hospitals and 61% concordantly low-performing hospitals). Similarly, composite race-specific RSRR (vs. race-agnostic) was associated with lower discordance rates in hospital performance for all patients and Black patients (Table 2). For RSMR, the composite race-specific (vs. race-agnostic) metric identified a higher proportion of low-performing hospitals for Black patients as concordantly low performing for all patients (55% vs. 45%) with a comparable concordance in identifying high-performing hospitals (Table-2). The concordance in hospital performance for all patients and White patients using the composite race-specific (vs. race-agnostic) metrics was comparable for RSRR and lower for RSMR (Table 3). High-performing hospitals for White patients that were concordantly high performing for all patients using the race-agnostic but not race-specific metrics had slightly worse RSMR and RSRR for patients of Black race than those that were high performing for all patients using both metrics (Table-S9).

Reclassification of hospital performance using the composite race-specific vs. race-agnostic metrics

Use of composite race-specific (vs. race-agnostic) RSRR reclassified performance rank quartiles of 35.8% of hospitals (17.5% up and 18.3% down classified). Among hospital subgroups, a greater proportion of safety-net hospitals (28.7% vs. 10.2%) and hospitals taking care of a higher proportion of dual coverage patients (44.5% vs. 1.1%) were upclassified in their performance status using the composite race-specific RSRR. Hospitals

that were upclassified in performance ranking had lower 30-day readmission and 1-year readmission across all races than hospitals that did not change rank (Table-4). Hospitals that were down-classified in performance rank using the composite race-specific (vs. race-agnostic) RSRR hospitals had higher 30-day readmission and 1-year readmission across all race/ethnicity groups. A similar pattern of results was observed for 30-day RSMR (39.2% of hospitals reclassified, 21.1% upclassified and 18.1% downclassified). Hospitals that were upclassified in performance rank based on the composite race-specific RSMR had lower readmission and mortality rates across all race/ethnicity groups than those with no change in hospital ranking (Table-4). Finally, hospitals with down classification in performance rank based on the composite race-specific (vs. race-agnostic) RSMR had higher mortality and readmission rates at 30-day and 1-year follow-up for all race/ethnicity groups than those with no change in their performance status.

Sensitivity Analyses—The correlation and concordance between composite race-specific hospital performance metrics for all patients vs. patients of Black race were higher among safety net (vs. non safety-net) hospitals (Tables-S10,S11) and among hospitals with high proportion of patients with dual coverage (Q4 vs. Q1–3, Tables-S12,S13). In sensitivity analyses using previously reported CMS risk adjustment models (instead of newly derived models used in the primary analyses), the composite race-specific RSRR/RSMR for all patients (vs. race-agnostic measures) demonstrated greater correlation and concordance with the respective measures for patients of Black and other races (Tables-S14,S15,S16). Finally, sensitivity analysis was performed whereby the race-specific 30-day RSRR and RSMR for all patients were estimated using a weighted average (based on the proportion of patients of each race) of these measures for each race group. The correlation pattern of *proportional weighted* race-specific RSRR/RSMR for all patients with these measures for Black and other races was worse than the race agnostic and equally weighted race-specific measures (Table-S17).

DISCUSSION

In the present study, we report several notable findings. First, there was a modest correlation between hospital-level 30-day RSRR and RSMR for White patients vs. Black patients and patients of other races hospitalized with HF. Second, compared with race-agnostic performance metrics, composite race-specific RSRR and RSMR for all patients had a stronger correlation with the corresponding performance metrics for Black patients. Third, only ~50% of hospitals identified as high or low performing using race-agnostic RSRR and RSMR for all patients were concordantly high or low performing for patients of Black race. In contrast, the concordance in hospital performance for all patients vs. patients of Black race was significantly greater using composite race-specific performance metrics. Finally, compared with race-agnostic 30-day RSRR and RSMR, composite race-specific performance metrics led to a meaningful reclassification of 36% and 39% hospitals, respectively, with better 30-day and 1-year outcomes in patients of all race/ethnicity groups among upclassified hospitals.

Black patients have a disproportionately higher HF hospitalization burden than White patients.[2,3,17,18] The racial disparities in HF and associated clinical presentations are

primarily driven by differences in SDOH and access to care.[7,19,20] Despite these race/ethnic differences, the current hospital-level performance metrics for HF patients are race-agnostic and are mainly representative of care and outcomes of the majority patient race/ethnicity group. Consistent with this notion, we observed that the race-agnostic RSRR/RSMR for all patients was very strongly correlated with RSRR of White patients but only modestly to poorly correlated with RSRR/RSMR for Black patients. The present study provides an alternative, more equitable approach to assessing hospital performance by utilizing race-specific measures of RSMR and RSRR.

The current readmission and mortality risk-standardization models do not account for race/ethnicity and SDOH, as doing so was perceived not to incentivize addressing inequity. However, recent studies have questioned this approach.[12,21,22] In 2016, the CMS implemented the 21st Century Cures Act whereby hospital performance is compared within peer-groups based on the proportion of dually enrolled patients with Medicaid and Medicare.[23] While the peer-group approach addresses the inequity in *inter-hospital* comparisons of performance,[24] it still does not account for the *within-hospital* differences in care quality and outcomes among patients of different race/ethnicity groups. The use of race-specific performance metrics addresses this issue by allowing for a greater representation of patients of Black race and other races outcomes in the overall hospital performance metric. It is noteworthy that concerns have been raised regarding the inclusion of race/ethnicity in risk adjustment models.[25] Specifically, HF risk models that include race as a covariate assign lower risk to Black patients and thus, may worsen the disparities in risk-based allocation of therapies.[25] Furthermore, incorporating race as a covariate may not capture the social factors contributing to racial disparities. The current study does not use race/ethnicity as a covariate. Instead, RSMR and RSRR are separately assessed within each race/ethnicity group, acknowledging the race/ethnicity differences in drivers of adverse outcomes to develop a model that better incorporates race-specific differences in risk.

Race-specific (vs. race-agnostic) metrics were associated with a stronger correlation and concordance between hospital performance for all patients and patients of Black and other races. This was largely driven by the equal weighting of each race group in the composite race-specific performance metric for the overall hospital population. Equal weighting was preferred over a proportionally weighted approach based on the rationale that the care quality and hospital performance standard should not differ across races by their proportional representation in the patient population. The equal-weighted composite race-specific metric of hospital performance demonstrated better correlation and concordance with the respective measures for patients of Black race than the race-agnostic and proportionally-weighted race-specific performance metrics. These findings suggest that the equal weighting approach can better represent the hospital's performance for patients of the Black race in overall performance metrics.

It is noteworthy that the correlation and concordance between hospital performance for all patients and White patients were high but slightly lower using composite race-specific RSMR vs. race-agnostic RSMR. This may be driven by the race-agnostic hospital performance metric being most representative of patients of the majority race group (most commonly White race). Thus, if a hospital has a lower-than-expected mortality rate for

patients of the majority White race group, it would be ranked as high performing by the race-agnostic metrics even if the mortality rates for the minoritized race groups are discordantly high. Consistent with this notion, we observed discordantly higher RSRR and RSMR among patients of Black and other races at the high-performing hospitals for the White race group that were identified as high performing by race-agnostic but not race-specific metrics for all patients.

Race-specific performance metrics were also associated with prognostically meaningful reclassification in the hospital performance status. Hospitals upclassified in performance ranking by race-specific (vs. race-agnostic) metrics had lower 30-day and 1-year readmission/mortality rates for each race/ethnicity group compared to hospitals that didn't change rank. Similarly, down-classified hospitals had higher 30-day and 1-year mortality among patients of all races than hospitals that didn't change rank.

A unique aspect of the composite race-specific metrics was the use of *race-specific* risk-standardized models, whereby separate risk models were developed for each race/ethnicity group. This is in contrast with the "one model for all" approach, currently implemented in the current CMS risk adjustment models that may be biased towards preferentially identifying risk factors most relevant for the majority race group.[26] While incorporating new race-specific models with additional variables may be more challenging to implement in the short-term, recent initiatives from the CMS encourage capturing health equity measures, including collecting sociodemographic and health-related social needs data, in the Hospital Inpatient Quality Reporting program.[27] Such initiatives can facilitate the development of risk-adjustment models that better account for SDOH and neighborhood-level factors and lead to more equitable hospital performance metrics, similar to the race-specific models used in the present study.

The composite race-specific metrics for all patients better captured the care and outcomes of Black patients among DSH (vs. non-DSH) hospitals and hospitals with a higher proportion of dual (Medicare + Medicaid) covered patients. Moreover, race-specific RSRR was associated with greater upclassification in the performance ranking of these hospitals providing care to socioeconomically disadvantaged patients. Altogether, the use of race-specific performance metrics will be less likely to identify hospitals caring for disadvantaged patients as low performing. In contrast, the race-agnostic performance metrics used currently by major pay-for-performance programs have demonstrated disproportionately higher readmission and mortality penalties at resource-limited hospitals serving predominately socioeconomically disadvantaged patients and patients of Black race.[21,28–30] These observations suggest that the use of race-specific hospital performance metrics may lower the existing disparities in the allocation of performance-based financial incentives and penalties among DSH vs. non-DSH hospitals.

Our study findings have important health policy implications. The nationwide adoption of publicly reported risk-standardized 30-day RSRR and RSMR was intended to inform and spur quality improvement and reduce costs at the hospital level.[31–33] However, these policies have stopped short of improving the existing racial disparities in care quality and outcomes.[28] Our study findings suggest that the current paradigm of assessing

hospital performance using risk-standardized metrics like RSRR and RSMR may not equitably capture hospital performance for patients of Black race. Thus, hospitals with disproportionately worse outcomes and care quality for Black (vs. White) patients may not be held accountable by the current metrics for the higher rates of adverse outcomes in Black patients, which represent a small percent of all patients. Our study provides an alternative, equitable approach for assessing hospital performance that would hold hospitals equally accountable for patient outcomes across all races and thus, better incentivize care quality improvement initiatives for all patients. Future studies are needed to determine if race-specific hospital performance metrics may help identify hospitals with disproportionately worse care and outcomes for patients of Black race or other races. Once identified, such hospitals may implement specific initiatives that are most relevant to improving care quality and outcomes among minoritized race groups.

Our study is not without limitations. First, our study cohort included only Medicare beneficiaries, which limited generalizability to younger adults who are ineligible for Medicare. Furthermore, we excluded hospitals that treated racially/ethnically homogenous patient populations (<30 patients of other races during the study period). This led to exclusion of 1,131 hospitals which may further limit generalizability. However, race-specific risk models are most relevant for hospitals with ethnic/racial heterogeneity in their patient population. Second, patients of self-reported Hispanic, Asian/Pacific Islander, and Native American race/ethnicity were grouped in one category (other races) to allow for enough sample size and power to calculate stable estimates of RSRR and RSMR. While this approach may limit the independent representation of these races in the composite race-specific metrics for all patients, considering the fewer number of patients for each of these race groups, calculating hospital-level RSRR/RSMR for each of these race groups separate would be statistically challenging. Third, while the composite race-specific metrics focus on achieving racial equity in hospital-level performance assessments, it does not address the existing disparities in hospital performance that may be related to poverty, gender, and other socioeconomic factors. Self-reported race is a social construct that captures an individual's lived experience and can be considered a proxy for socially disadvantaged patients. Thus, the composite race-specific performance metric that better captures the performance of hospitals for patients of self-reported Black and other races will also better capture outcomes of poor and socioeconomically disadvantaged patients. We have included neighborhood-level SDOH in the race-specific risk-adjustment model that may better account for disparities related to these factors. Assessment of patient-level SDOH, as encouraged by the recent CMS initiative,[27] and their incorporation in risk-adjustment models may further improve the performance of race-specific models. Finally, the present study focuses on RSMR and RSRR metrics, which are imperfect hospital performance measures, as shown by multiple recent studies, and hospital performance metrics that are more patient-centered and comprehensive in the assessment of hospital care quality and outcomes are needed.[34,35] Future studies are needed to evaluate the race-specific approach in the context of other novel and patient-centered performance metrics.

In conclusion, composite race-specific 30-day RSRR and RSMR as a hospital performance metric may better assess care quality for Black patients and patients of other races compared with the currently used race-agnostic 30-day metrics. Future studies are needed to evaluate

if race-specific approaches to assessing hospital performance may be associated with more equitable gains in care quality and outcomes across all races.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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NON-STANDARD ABBREVIATIONS AND ACRONYMS

HF	– heart failure
CMS	Centers for Medicare and Medicaid Services
RSRR	risk-standardized readmission rate
RSMR	risk-standardized mortality rate
VBP	Value-Based Purchasing Program
HRRP	Hospital Readmissions Reduction Program
SDOH	social determinants of health
ICD	International Classification of Diseases
SDI	Social Deprivation Index
DCI	Distressed Community Index

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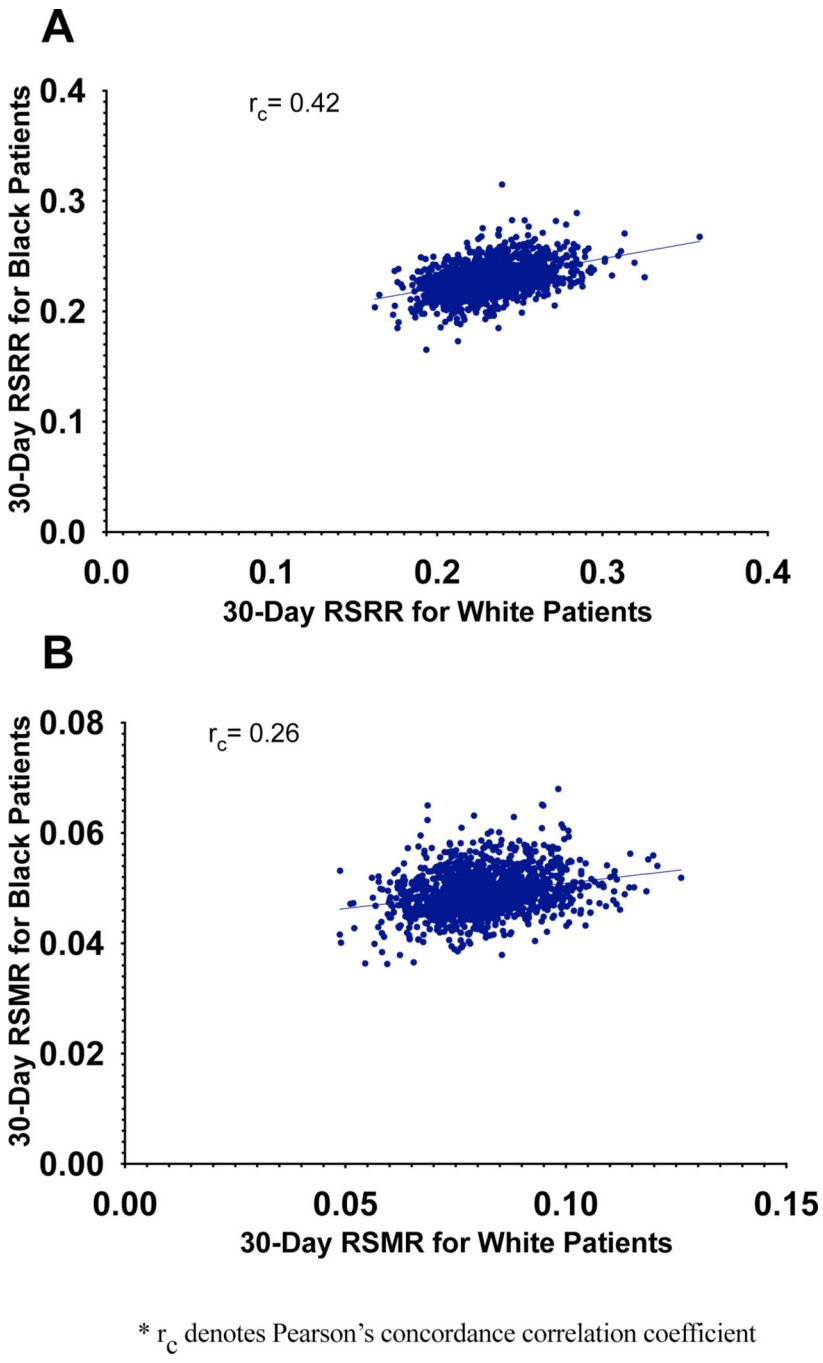
CLINICAL PERSPECTIVE

What is New?

- Compared with the currently used race-agnostic hospital performance measures (risk-standardized readmission and mortality rates), composite race-specific metrics better capture the care quality, outcomes, and hospital performance for Black patients and patients of other races.
- Composite race-specific (vs. race-agnostic) measures reclassified performance ranking for a substantial proportion of hospitals, with better 30-day and 1-year outcomes at hospitals reclassified as high-performing.

What are the clinical implications?

- Composite race-specific metrics for HF provide a more equitable representation of hospital performance for patients of Black patients and patients of other races.

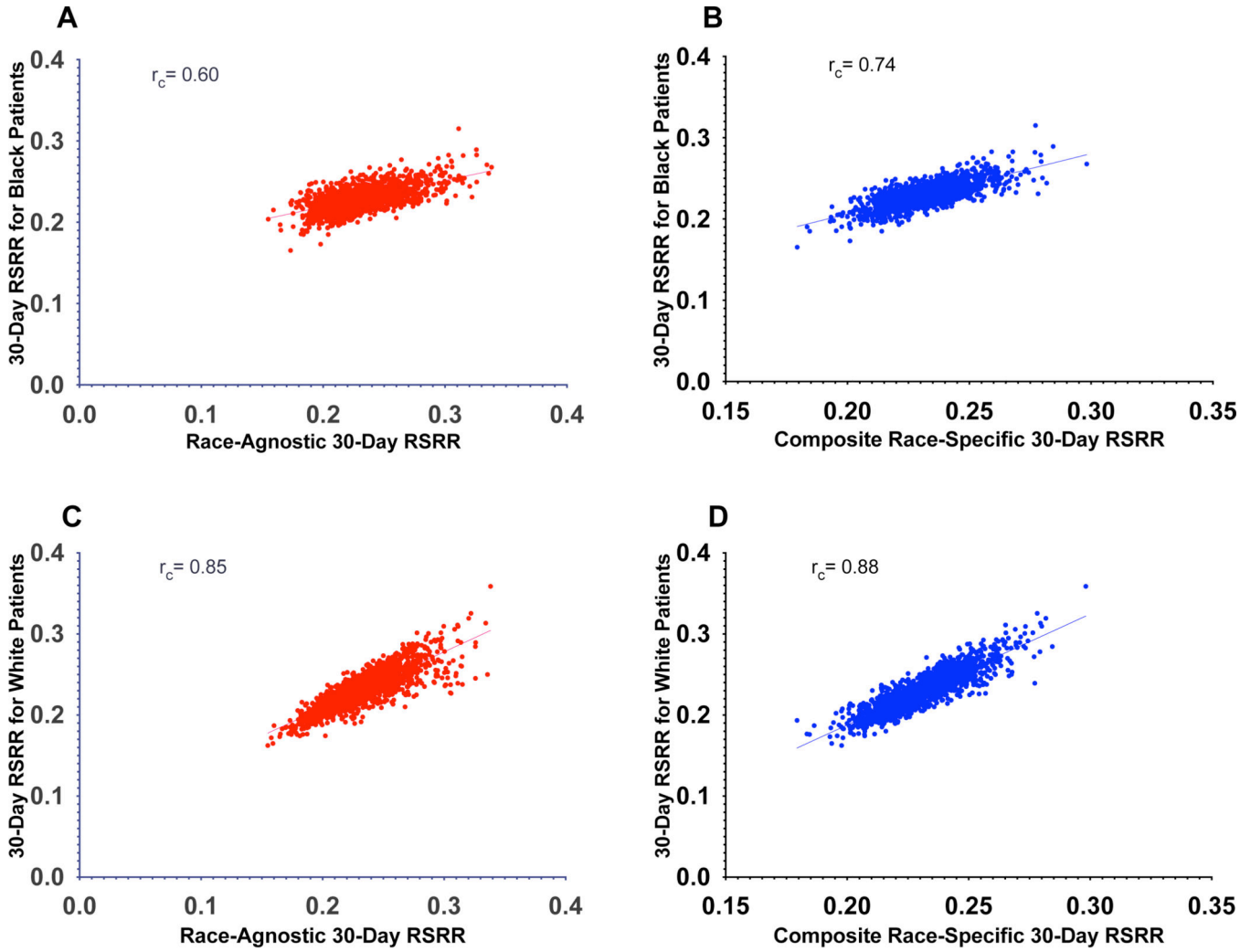


* r_c denotes Pearson's concordance correlation coefficient

Figure 1:

(A) Correlation in 30-day risk-standardized readmission rates (RSRR) between White patients and Black patients **(B)** Correlation in 30-day risk-standardized mortality rates (RSMR) between White patients and Black patients

* r_c denotes correlation coefficient

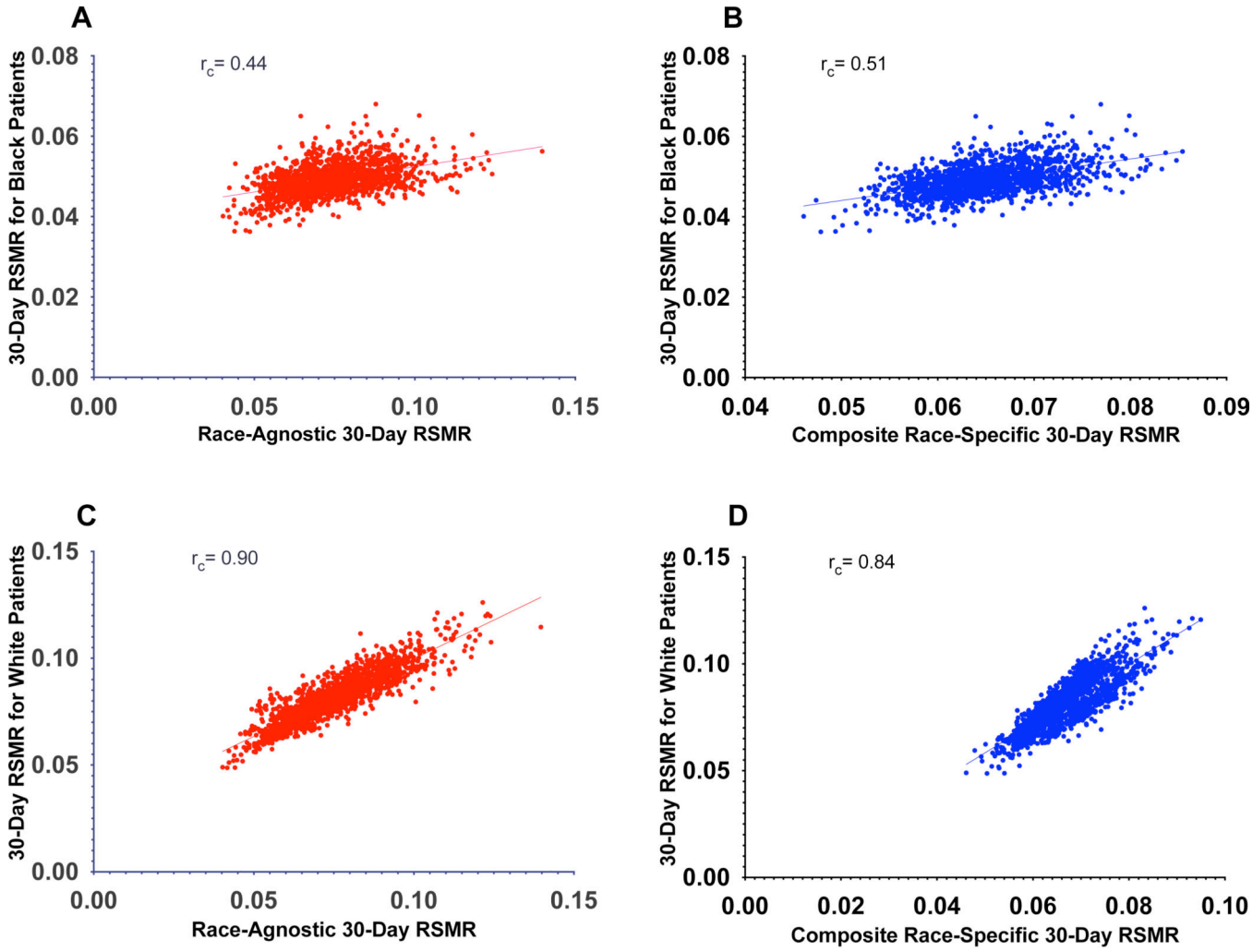


* r_c denotes Pearson's concordance correlation coefficient

Figure 2:

(A) Correlation of race-agnostic 30-day risk-standardized readmission rates (RSRR) for all patients with the 30-day RSRR for Black patients. **(B)** Correlation of race-specific 30-day RSRR for all patients with the 30-day RSRR for Black patients. **(C)** Correlation of race-agnostic 30-day RSRR for all patients with the 30-day RSRR for White patients. **(D)** Correlation of race-specific 30-day RSRR for all patients with the 30-day RSRR for White patients

* r_c denotes correlation coefficient



* r_c denotes Pearson's concordance correlation coefficient

Figure 3:

(A) Correlation of race-agnostic 30-day risk-standardized readmission rates (RSMR) for all patients with 30-day RSMR for Black patients. **(B)** Correlation of race-specific 30-day RSMR for all patients with 30-day RSRR for Black patients. **(C)** Correlation of race-agnostic 30-day RSMR for all patients with the 30-day RSMR for White patients. **(D)** Correlation of race-specific 30-day RSMR for all patients with the 30-day RSMR for White patients.

* r_c denotes correlation coefficient

Table 1:

Hospital characteristics and 30-day performance metrics across quartiles of race specific 30-day RSRR and RSMR

	Race-Specific 30-Day RSRR					Race-Specific 30-Day RSMR				
	Q1 (Highest-performing)	**Q2**	**Q3**	**Q4 (lowest-performing)**	**P value**	**Q1 (Highest-performing)**	**Q2**	**Q3**	**Q 4 (Lowest-performing)**	**P value**
No. of beds, (median, 25th-75th)	321 (212–468)	243 (149–401)	238 (139–366)	190 (109–315)	<0.001	329 (201–520)	259 (156–390)	225 (134–377)	193 (110–293)	<0.001
Teaching affiliation (%)					<0.001					
Major	15.7	15.1	10.3	7.0		21.4	14.5	8.1	4.1	<0.001
Minor	61.6	52.7	47.8	45.0		51.2	51.3	53.5	51.3	
Non-teaching	22.6	32.2	41.9	48.0		27.4	34.2	38.4	44.6	
Ownership (%)					<0.001					0.03
Government	12.7	11.6	12.9	14.2		12.5	12.3	12.5	14.1	
Investor	12.3	19.0	26.0	31.2		16.6	23.2	22.7	25.9	
Not Profit	75.0	69.4	61.1	54.6		70.9	64.5	64.9	60.0	
Rural (%)	4.0	11.6	14.0	17.5	<0.001	4.8	10.0	14.6	17.4	<0.001
Region (%)					<0.001					<0.001
Midwest	22.2	16.6	17.7	11.2		27.9	17.1	14.9	8.2	
Northeast	8.3	14.8	19.0	26.3		20.2	18.2	17.5	12.3	
Southeast	27.0	29.6	34.2	38.7		30.3	35.8	35.1	28.3	
Southwest	14.6	15.2	15.2	12.7		12.7	16.5	13.8	14.7	
West	27.9	13.9	13.9	11.2		9.7	12.4	18.6	36.5	
Safety-net hospital (%)	29.9	32.9	32.3	28.8	0.5	31.2	29.9	34.0	28.8	0.8
High Medicaid hospital (%)	22.4	26.0	25.0	26.7	0.5	25.4	23.2	26.5	25.0	0.7
30-day Risk-Standardized Readmission and Mortality Rates for Different Race/Ethnicity Groups										
Patients of White race	20.8 (19.8–21.5)	22.2 (21.6–22.8)	23.6 (22.9–24.5)	25.5 (24.6–26.6)	<0.001	7.1 (6.6–7.4)	7.9 (7.6–8.2)	8.6 (8.1–8.9)	9.3 (8.5–9.9)	<0.001
Patients of Black race	21.7 (20.9–22.4)	22.7 (22.1–23.3)	23.2 (22.6–23.8)	24.2 (23.4–25.1)	<0.001	4.7 (4.5–4.9)	4.9 (4.7–5.1)	5 (4.8–5.2)	5.2 (4.9–5.5)	<0.001
Patients of other race/ ethnicity	22.1 (21.3–22.8)	23.2 (22.5–23.8)	23.8 (23.2–24.5)	24.7 (23.9–25.7)	<0.001	6 (5.8–6.3)	6.2 (6–6.4)	6.4 (6.1–6.7)	6.5 (6.3–6.7)	<0.001

Hospital characteristics are reported in quartiles as median (25^{th} and 75^{th} percentile) for continuous variables and proportion for categorical variables.

Safety net hospitals were hospitals in the highest quartile for the disproportionate share hospital index.

High Medicaid hospitals were hospitals in the top quartile of dual-eligible Medicaid and Medicare patients treated in each hospital.

Abbreviations: RSRR – risk-standardized readmission rate; RSMR – risk-standardized mortality rate.

Table 2:

Concordance in hospital performance between overall 30-day RSRR and RSMR (assessed using race-specific and race-agnostic approaches) for all patients and 30-day RSRR and RSMR for black patients

	***Race-Agnostic* 30-Day RSRR for all patients**	
30-Day RSRR in Black Patients	Highest Performing Quartile	Lowest Performing Quartile
Highest Performing Quartile	53.3	3.9
Lowest Performing Quartile	5.9	50.8
	***Race-Specific* 30-Day RSRR for all patients**	
30-Day RSRR in Black Patients	Highest Performing Quartile	Lowest Performing Quartile
Highest Performing Quartile	64.1	1.3
Lowest Performing Quartile	2.6	60.5
	***Race-Agnostic* 30-Day RSMR for all patients**	
30-Day RSMR in Black Patients	Highest Performing Quartile	Lowest Performing Quartile
Highest Performing Quartile	48.0	7.4
Lowest Performing Quartile	8.2	44.7
	***Race-Specific* 30-Day RSMR for all patients**	
30-Day RSMR in Black Patients	Highest Performing Quartile	Lowest Performing Quartile
Highest Performing Quartile	48.0	6.8
Lowest Performing Quartile	7.1	55.1

Race-specific and race-agnostic 30-day RSRR and RSMR were stratified into quartiles of performance and compared to quartiles of performance in 30-day RSRR or RSMR specifically for Black adults.

Percentages represent concordance in hospital performance (highest performing or lowest performing in both groups) or discordance in hospital performance (highest performing in one group and lowest performing in the other group, or lowest performing in one group and highest performing in the other group).

Abbreviations: RSRR – risk-standardized readmission rate; RSMR – risk-standardized mortality rate

Table 3:

Concordance in hospital performance based on overall 30-day RSRR and RSMR for all patients (using race-specific and race-agnostic metrics) and 30-day RSRR and RSMR for White patients.

	***Race-Agnostic* 30-Day RSRR for all patients**	
30-Day RSRR in White Patients	Highest Performing Quartile	Lowest Performing Quartile
Highest Performing Quartile	74.4	0.5
Lowest Performing Quartile	0	70.3
	***Race-Specific* 30-Day RSRR for all patients**	
30-Day RSRR in White Patients	Highest Performing Quartile	Lowest Performing Quartile
Highest Performing Quartile	74.1	0.2
Lowest Performing Quartile	0	75.6
	***Race-Agnostic* 30-Day RSMR for all patients**	
30-Day RSMR in White Patients	Highest Performing Quartile	Lowest Performing Quartile
Highest Performing Quartile	79.4	0
Lowest Performing Quartile	0.2	78.9
	***Race-Specific* 30-Day RSMR for all patients**	
30-Day RSMR in White Patients	Highest Performing Quartile	Lowest Performing Quartile
Highest Performing Quartile	76.0	0.9
Lowest Performing Quartile	0	65.6

Race-specific and race-agnostic 30-day RSRR and RSMR were stratified into quartiles of performance and compared to quartiles of performance in 30-day RSRR or RSMR specifically for White adults.

Percentages represent concordance in hospital performance (highest performing or lowest performing in both groups) or discordance in hospital performance (highest performing in one group and lowest performing in the other group, or lowest performing in one group and highest performing in the other group).

Abbreviations: RSRR – risk-standardized readmission rate; RSMR – risk-standardized mortality rate

Table 4:

30-day and 1-year outcomes in up- and down-classified hospitals based on quartiles of race-specific 30-day risk-standardized readmission rate and 30-day risk-standardized mortality rate compared to race-agnostic 30-day risk-standardized readmission rate and risk-standardized mortality rate.

Race-Specific 30-Day RSRR for all patients						
Outcomes	**Up Classified *N* = *325***	**Rank Unchanged *N* = *844***	**P value**	**Down Classified *N* = *340***	**Rank Unchanged *N* = *837***	**P Value**
Black Patients						
30-day readmission	22.6	24.0	<0.001	22.8	20.8	<0.001
1-year readmission	68.3	69.2	0.001	67.5	66.9	0.02
Patients of Other Races						
30-day readmission	23.5	24.6	<0.001	23.9	20.7	<0.001
1-year readmission	67.8	67.3	0.1	64.6	64.0	0.1
White Patients						
30-day readmission	23.8	24.7	<0.001	22.1	21.2	<0.001
1-year readmission	64.9	65.0	0.5	63.4	62.0	<0.001
Race-Specific 30-Day RSMR for all patients						
	Up Classified *N* = *393*	**Rank Unchanged *N* = *771***	**P value**	**Down Classified *N* = *336***	**Rank Unchanged *N* = *812***	**P Value**
Black Patients						
30-day mortality	5.1	5.6	<0.001	5.1	4.5	<0.001
1-year mortality	29.3	29.9	0.009	29.3	28.0	<0.001
Patients of Other Races						
30-day mortality	6.5	7.2	<0.001	6.6	5.6	<0.001
1-year mortality	30.1	31.2	0.005	31.0	28.5	<0.001
White Patients						
30-day mortality	8.3	9.0	<0.001	7.8	7.3	<0.001
1-year mortality	36.6	37.3	<0.001	35.7	35.2	<0.001

The outcomes are presented as % of patients with the event of interest

Upclassified hospitals had greater than 1 category improvement in performance rank, while downclassified hospitals had greater than 1 category worsening in performance rank.

Hospitals not eligible for upclassification or downclassification due to already being in the highest or lowest performance category are not shown.