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Racial Differences In Hospital Use After Acute Myocardial Infarction: Does Residential Segregation Play A Role?:

Black Medicare beneficiaries used high-mortality hospitals more often than their white peers, despite their geographic proximity to lower-mortality hospitals

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Abstract

This study compares the likelihood of admission to high-mortality hospitals for black and white Medicare patients in 118 health care markets, and whether admission patterns vary if residential racial segregation is greater in the area. Risk of admission to high-mortality hospitals was 35 percent higher for blacks than for whites in markets with high residential segregation. Moreover, blacks were more likely than whites to be admitted to hospitals with high mortality, even in analyses limited to patients who lived closest to lower-mortality hospitals. Eliminating health care disparities may require policies that address social factors leading to segregation.

Differences in access to high-quality providers have been documented among racial and ethnic groups.¹ Such differences may be a symptom of racial segregation in the health care delivery system. Segregation has been widely studied as a cause of educational and socioeconomic inequities; however, few studies have examined segregation of health services or how segregation contributes to racial disparities. Nevertheless, the rationale for investigating the segregation of health services is compelling, given the history of segregated health care delivery in the United States and the evidence of differential access to high-quality providers.

This study investigates the relationship between racial segregation and admission to high-mortality hospitals for acute myocardial infarction (AMI)—a condition for which there is much evidence of disparities in processes of care and outcomes.² The study examines residential and hospital racial segregation and evaluates their relationship to the use of high-mortality hospitals, after accounting for the influence of income and geographic proximity.

Study Data And Methods

Patient population

Regional markets for hospital care were defined using Hospital Referral Regions (HRRs), as defined for the *Dartmouth Atlas of Health Care*.³ The analysis was restricted to 122 HRRs with a minimum of 5,000 black Medicare Part A enrollees annually during 2000–2005, to ensure adequate numbers of black patients within individual markets. Four HRRs that did not have at least one hospital categorized as high mortality were excluded, leaving 118 markets. Admissions to acute care hospitals in the 118 HRRs during 2000–2005 with a principal diagnosis of AMI (*International Classification of Diseases*, Ninth Revision, Clinical Modification [ICD-9-CM], code 410) were identified in Medicare Provider Analysis and Review (MedPAR) files. The MedPAR files contain discharge data for Medicare fee-for-service hospitalizations, including demographics; dates of admission, discharge, or death; and principal and secondary ICD-9-CM diagnosis and procedure codes. The MedPAR files identified 1,095,117 white and 129,984 black patients within the 118 HRRs, representing 60 percent and 89 percent of all admissions nationally for white and black patients, respectively. The following three groups were then excluded: (1) 369,807 (34 percent) white and 39,767 (31 percent) black patients who were transferred from another acute care facility or who had an admission for AMI or coronary revascularization during the three years prior to the current admission (to minimize the impact of prior AMI care); (2) 61,902 (6 percent) white and 13,465 (10 percent) black patients younger than age sixty-eight (to ensure at least three years of prior Medicare data); and (3) 77,425 (7 percent) white and 8,637 (7 percent) black patients whose residence ZIP code was outside the HRR or who could not be matched to ZIP code–level census data. These exclusions left 585,983 white and 68,115 black patients in the final sample.

Data

Hospitals' risk-adjusted mortality was measured by the ratio of observed mortality rate to expected mortality rate (known as the O/E ratio) within thirty days of admission. Expected mortality was based on logistic regression models that adjusted for patients' risk factors, including demographics (age, sex, and median household income from 2000 U.S. census ZIP code data), accompanying health conditions (defined by ICD-9-CM secondary diagnosis codes), admission through the emergency department (ED), and location of the myocardial infarction (categorized by the primary ICD-9-CM code as anterior/lateral, inferior/posterior, subendocardial, or unspecified location).⁴ Models also included interactions between race and two patient risk factors (age and ZIP code–level income), two hospital-level variables (percentage of AMI patients who were black and median income of AMI patients), and hospital-level random effects.⁵ The inclusion of the two hospital-level variables and random effects accounts for variation in mortality attributable to underlying characteristics of hospitals treating large proportions of black or low-income patients. This approach minimizes the likelihood that resulting coefficients for patient risk factors are confounded by unobserved characteristics of the admitting hospital.⁶

The coefficients associated with the patient risk factors were used to calculate the expected mortality for each patient at an “average” hospital (that is, a hospital with average median

income and average percentage of black patients). Expected mortalities were then averaged to obtain a mean expected mortality rate for each hospital. O/E ratios were determined by dividing the observed (actual) mortality rate by the expected mortality rate for each hospital. O/E ratios were then used to identify “high-mortality” hospitals. First, patients were ranked by the O/E ratio of the admitting hospital, and one-third of patients ($n = 221,728$) were categorized as being admitted to high-mortality hospitals—998 of the total 2,414 hospitals. The median O/E for the 998 hospitals was significantly higher than for the remaining hospitals (1.19 versus 0.88; $p < 0.001$).

Segregation was measured using the Dissimilarity Index, which reflects the evenness with which two population groups are distributed across units (such as hospitals or neighborhoods) within HRRs.⁷ The index varies between 0 (no segregation) and 1 (complete segregation) and represents the proportion of blacks who would have to relocate to a different unit (that is, be admitted to a different hospital or reside in a different neighborhood) to achieve an even distribution. An example of an HRR with high dissimilarity for hospital admissions is Detroit, Michigan, with a Dissimilarity Index of 0.79. In this market, two of its fifteen hospitals accounted for 62 percent of all black AMI admissions but only 4 percent of all white admissions. The hospital accounting for the largest proportion of white AMI admissions (17 percent) had less than 1 percent of the market’s black admissions.

Hospital segregation within the 118 HRRs was calculated using MedPAR data for AMI admissions. HRRs were categorized as having low, medium, or high segregation by ranking them by their Dissimilarity Indices and assigning segregation categories so that one-third of patients were in each category. A second Dissimilarity Index for residential segregation was calculated using 2000 U.S. census-tract population data, after matching census tracts to HRRs using U.S. census ZIP Code Tabulation Areas (ZCTAs).⁸ Other characteristics of HRRs were calculated using patient-level MedPAR data, American Hospital Association (AHA) surveys, and 2000 census data.

Analysis

The proportions of black and white patients admitted to high-mortality hospitals were compared for black and white patients overall and within segregation categories. Logistic regression models were used to determine the relative risk of admission to a high-mortality hospital after adjusting for potential confounders. Predictor variables in the logistic regression models included an indicator variable for black race, year of discharge, median income for the patient’s ZIP code, distance from the patient’s residence to the nearest high-mortality hospital (based on straight-line distance between hospital and residence ZIP codes), incremental distance to the nearest hospital that was not high mortality, indicators for segregation category (low, medium, high), and the interaction between race and segregation categories. The resulting model provided the estimated odds of admission to a high-mortality hospital for blacks relative to whites within each of the three segregation categories; odds ratios were then converted to relative risk ratios.⁹ Separate models were developed for the Dissimilarity Index based on hospital and residential segregation. To account for the nesting of patients within HRRs, models included random intercepts and

random coefficients for black race, which were assumed to be normally distributed across HRRs.¹⁰ Additional analyses further investigated the effect of geographic proximity to lower-mortality hospitals by repeating these analyses in the subset of patients whose closest hospital was not categorized as high mortality, and in the subset of patients living within two miles of a hospital not categorized as high mortality (based on straight-line distance between patient and hospital ZIP codes).

Study Results

Mean Dissimilarity Index values for the 118 HRRs, based on hospital and residential segregation, were 0.39 (standard deviation: 0.15) and 0.59 (SD: 0.13), respectively. Index values based on hospital and residential segregation were highly correlated ($r = 0.72$; $p < 0.001$), although agreement was only moderate ($\kappa = 0.50$); 82 percent of HRR markets ranked as having high hospital segregation also had high residential segregation, and 67 percent of HRRs with low hospital segregation also had low residential segregation. HRRs with high segregation had greater numbers of hospitals, AMI patients, and hospital beds per square mile, and higher population density (Exhibit 1). The 118 study HRR markets were distributed unevenly across four census regions. The South had the most HRRs (72) but the lowest proportion with high hospital segregation (6 percent) or high residential segregation (6 percent). The Midwest accounted for only eighteen HRRs but had the highest proportion with high hospital and residential segregation (67 percent and 89 percent, respectively). The Northeast and West accounted for eighteen and ten HRRs, respectively.

Black patients were slightly younger than whites and were more likely ($p < 0.001$) to be female, to live in ZIP codes with lower median household income, and to have chronic renal disease and subendocardial infarctions, but were less likely to have chronic obstructive pulmonary disease (COPD; results not shown). Other differences were statistically significant but were too small to be of clinical relevance.

Using the mean O/E ratio to represent risk-adjusted mortality, the hospitals to which black patients were admitted had greater mortality (mean O/E = 1.03), compared with hospitals to which white patients were admitted (mean O/E = 0.98; $p < 0.001$). For white patients, the mean O/E ratios of the admitting hospital decreased with increasing hospital segregation (1.00, 0.98, and 0.95 in markets with low, medium, and high hospital segregation, respectively). For black patients, mean O/E ratios increased slightly as hospital segregation increased (1.02, 1.04, and 1.04, respectively).

Overall, black patients were more likely than whites to be admitted to high-mortality hospitals (45 percent versus 33 percent; $p < 0.001$); again, this difference increased with segregation (Exhibit 2). Blacks were 13 percent (that is, 44 percent/39 percent) more likely than whites to be admitted to high-mortality hospitals in HRRs with low hospital segregation but were more than 90 percent (46 percent/24 percent) more likely than whites to be admitted to high-mortality hospitals in HRRs with high hospital segregation. Results were similar based on residential segregation. In hierarchical logistic regression analyses, the adjusted relative risk of admission to high-mortality hospitals was 21 percent higher ($p = 0.06$) for blacks compared to whites in HRRs with high hospital segregation, and 35 percent

higher ($p < 0.001$) in HRRs with high residential segregation; however, the adjusted relative risk of admission to high-mortality hospitals did not differ in HRRs with low or medium hospital or residential segregation.

Overall, black patients were more likely than white patients to live closest to a high-mortality hospital (48 percent versus 38 percent; $p < 0.001$). Nevertheless, in analyses restricted to patients whose closest hospital was not high mortality, blacks were still more likely ($p < 0.001$) than whites to be admitted to a hospital other than the closest hospital (50 percent versus 43 percent) or to a high-mortality hospital (21 percent versus 12 percent) (Exhibit 3). These differences increased with both hospital and residential segregation. Moreover, after year, income, and distances to hospitals were adjusted for, the relative risk of admission to a high-mortality hospital remained 1.43 and 1.58 (both $p < 0.001$) times higher for blacks in HRRs with high hospital segregation and high residential segregation, respectively, but did not differ significantly ($p > 0.10$) in HRRs with low or medium hospital or residential segregation. Analyses limited to patients residing within two miles of a lower-mortality hospital produced similar results. For example, in HRRs with high hospital segregation, black patients were 1.28 times more likely than white patients to reside within two miles of a hospital with lower mortality (50 percent versus 39 percent) but were nevertheless 1.18 times more likely than whites to be admitted to a hospital more than two miles away (39 percent versus 33 percent and three times more likely to be admitted to a high-mortality hospital (34 percent versus 11 percent; all $p < 0.001$). After multivariable adjustment, the relative risk of admission to a high-mortality hospital for these patients was still 1.35 (95 percent confidence interval: 1.06, 1.71; $p < 0.001$) times higher in HRRs with high residential segregation but was not related to hospital segregation.

“Blacks living in highly segregated areas may feel unwelcome in majority-white hospitals, even if such hospitals are accessible.”

Discussion And Policy Implications

This is the first study to examine relationships between segregation in individual health care markets and racial differences in admissions to high-mortality hospitals. Our findings are consistent with prior literature of racial disparities in access to high-quality care, particularly for cardiac disease.¹¹ This study further demonstrates the potential role of segregation in promoting such differences. Previous research has linked residential segregation to racial disparities in health care access and outcomes.¹² However, we know of only one other study that examined segregation of hospital services.¹³ The high degree of correlation between hospital and residential segregation we found suggests that hospitals are segregated largely because they reflect the residential areas they serve. Nevertheless, we still found that black patients residing closest to lower-mortality hospitals were admitted more often to high-mortality hospitals and to hospitals other than the closest one—an unexpected finding, given that AMI patients are typically directed to the closest hospital. This suggests that factors other than geographic proximity drive racial differences. Lack of insurance also does not explain our results, because all patients in our data have Medicare Part A (Hospital Insurance). Indeed, other studies suggest that even if geographic and financial barriers were eliminated, large disparities would still persist.¹⁴

Explanatory factors

We point to several social factors to explain our findings. First, segregation of patients across hospitals may be related to physician referrals. Before the 1960s, health care was often segregated by race, with separate hospitals for black and white patients and separate systems for training clinicians.¹⁵ Although these practices are no longer sanctioned, old patient referral patterns may prevail, effectively limiting access to high-quality hospitals for blacks. For example, black patients are more likely to be treated by black physicians—either by choice or because access to white physicians is limited.¹⁶ Black physicians, in turn, are more likely to practice in hospitals with a tradition of caring for black patients.¹⁷ It has also been shown that hospitals treating large proportions of black patients serve a disproportionate share of uninsured populations and therefore face financial pressures that compromise quality.¹⁸ Although our sample does not include uncompensated care, underlying racial patterns of hospital referral likely affect the Medicare population in much the same way. Blacks are also more likely than whites to use hospital EDs as a usual source of care, which may also limit physician referrals to higher-quality hospitals.¹⁹

Culture and patient preferences may also intensify existing hospital segregation. Blacks living in highly segregated areas may feel unwelcome in majority-white hospitals, even if such hospitals are accessible. Indeed, cultural concordance is an important component of health services delivery for blacks and may play an important role in determining choice of hospitals.²⁰

Limitations

This study has potential limitations. First, the study includes elderly Medicare fee-for-service patients only. The magnitude and effects of segregation for patients with other insurance or no insurance, or who are younger, may differ. Second, distances between patient residence and hospitals were calculated using straight-line distances between ZIP code centroids and did not consider travel time. However, prior evidence suggests that the use of actual street addresses or travel time would be unlikely to change our results.²¹

Third, segregation is complex and may occur in a variety of ways (for example, isolation of one group from another, spatial concentration, centralization, or clustering). The Dissimilarity Index represents the evenness with which two population groups are spread across units. It was chosen for this study because it is easy to interpret, relatively simple to calculate, and widely used in the social sciences.²² Dimensions of segregation other than evenness were not evaluated. Moreover, segregation may be related to other market characteristics (such as market size) that underlie relationships between race and admission to high-mortality hospitals. Directly adjusting for other characteristics is difficult because of the dependence between other market characteristics and segregation. However, results were similar in analyses of HRRs stratified by number of hospitals (that is, >15 [n = 56 HRRs] and ≤15 [n = 65]), percentage of Medicare beneficiaries who are black (>10 percent [n = 61] and ≤10 percent [n = 57]), and population density per square mile (>186 [n = 59] and ≤186 [n = 59]; results not shown).

Fourth, correlates of disparities vary significantly across U.S. regions and communities.²³ Our study included only 118 of 306 possible HRRs—with the majority located in the South and having a higher proportion of black patients compared to HRRs that were not included. Disparities also vary by disease, and our investigation of AMI hospitalizations might not generalize to other conditions.

Fifth, defining *high-mortality hospitals* to include one-third of all patients was somewhat arbitrary. In additional analyses, we defined them to include only one-fifth of all patients ($n = 740$ hospitals). Using this definition, we found a stronger effect of segregation on disparities. For example, the risk-adjusted likelihood of admission to a high-mortality hospital, using the revised definition, was 1.39 ($p = 0.006$) times higher for blacks compared to whites in HRRs with high hospital segregation, and 1.45 ($p = 0.002$) times higher in HRRs with high residential segregation.

Finally, O/E mortality ratios are widely used as a proxy for hospital quality. However, expected mortality for a given hospital may be underestimated if key indicators of patient severity are unmeasured, resulting in an inflated O/E ratio. Thus, it is possible that blacks were either more likely than whites to be admitted to hospitals with low quality, or more likely to be admitted to hospitals with substantial unmeasured patient severity.

DESPITE THESE LIMITATIONS, THIS STUDY TAKES an important step toward identifying causes of racial disparities. Sanctioned segregation of hospitals was eliminated during the 1960s, but de facto segregation remains. We believe that future research in racial disparities should more explicitly examine segregation and the extent to which structural aspects of the health care delivery system or deeper sociocultural divisions promote segregation. Moreover, our findings suggest that eliminating racial disparities in health care may require policies that consider entrenched social factors driving racial segregation.

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EXHIBIT 1

Characteristics Of Markets With Low, Medium, And High Hospital And Residential Segregation For Black And White Patients Admitted For Acute Myocardial Infarction (AMI) During 2000–2005

Characteristics	Hospital segregation category			
	Low	Medium	High	
Number of markets	60	31	27	
Total AMI patients during 2000–2005	218,958	223,503	211,637	
	Median (Interquartile range)			p value^a
Hospitals per market	12 (7–14)	22 (14–29)	27 (15–37)	<0.001
Hospital beds per square mile	0.44 (0.32–0.73)	0.97 (0.52–2.32)	0.83 (0.46–3.38)	<0.001
Total AMI patients per market (annual)	480 (351–756)	1,092 (700–1,566)	1,193 (746–1,956)	<0.001
Black AMI patients per market (annual)	60 (38–107)	54 (35–99)	90 (35–237)	0.49
Mean percent of patients who were black	15% (8–22)	6% (4–9)	7% (5–13)	<0.001
Mean annual number of Medicare Part A enrollees per market	85,263 (56,222–136,361)	198,054 (163,190–283,258)	251,481 (151,034–316,092)	<0.001
Population density (per square mile)	114 (68–252)	292 (148–664)	334 (168–1,133)	<0.001
	Residential segregation category			
	Low	Medium	High	
Number of markets	60	29	29	
Total AMI patients per market during 2000–2005	214,748	225,923	213,427	
	Median (Interquartile range)			p value^a
Hospitals per market	12 (8–16)	22 (13–37)	19 (8–33)	<0.001
Hospital beds per square mile	0.42 (0.31–0.58)	0.66 (0.46–1.24)	2.32 (0.84–4.36)	<0.001
Total AMI patients per market (annual)	484 (343–776)	1,118 (744–1,893)	1,109 (661–1,873)	<0.001
Black AMI patients per market (annual)	51 (35–95)	57 (35–127)	96 (47–236)	0.03
Mean percent of patients who were black	12 (7–21)	6 (4–13)	9 (6–14)	<0.001
Mean annual number of Medicare Part A enrollees per market	90,599 (52,225–155,476)	194,682 (163,190–321,481)	210,905 (113,292–299,970)	<0.001
Population density (per square mile)	104 (64–180)	248 (134–444)	664 (334–1,527)	<0.001

SOURCES: Authors' calculations using Centers for Medicare and Medicaid Services (CMS) Medicare Provider Analysis and Review (MedPAR) files (for numbers of patients, hospitals, and percentage of patients who are black); CMS Denominator files (for number of Part A enrollees); American Hospital Association 2003 survey data (for hospital beds); and U.S. 2000 censustract data (for market square miles, after assigning census tracts to Hospital Referral Region markets using U.S. census ZIP Code Tabulation Areas).

^a
p values for the difference across markets are based on the Kruskal-Wallis nonparametric test.

EXHIBIT 2

Proportions Of Black And White Patients Admitted To High-Mortality Hospitals, And The Adjusted Relative Risk Of Admission To High-Mortality Hospitals For Blacks Relative To Whites, 2000–2005

Segregation	Whites (n = 585,984)		Blacks (n = 68,115)		Risk-adjusted relative risk (95%CI; <i>p</i> value)
	Number	Percent	Number	Percent	
Overall	191,093	33	30,635	45	1.12 (1.03–1.21; <i>p</i> = 0.013)
Hospital segregation					
Low	74,073	39 ^a	13,215	44	1.05 (0.94–1.17; <i>p</i> = 0.39)
Medium	70,751	34	7,437	46	1.17 (0.99–1.35; <i>p</i> = 0.06)
High	46,269	24	9,983	46	1.21 (0.99–1.46; <i>p</i> = 0.06)
Residential segregation					
Low	71,337	38	10,281	40	1.05 (0.94–1.17; <i>p</i> = 0.37)
Medium	69,705	33	8,204	48	1.04 (0.87–1.22; <i>p</i> = 0.69)
High	50,051	27	12,150	48	1.35 (1.13–1.58; <i>p</i> < 0.001)

SOURCE: Authors' calculations using Centers for Medicare and Medicaid Services (CMS) Medicare Provider Analysis and Review (MedPAR) (Part A) data for 2000–2005.

NOTES: Relative risks were determined using generalized linear mixed logit models with random effects for Hospital Referral Regions (HRRs) and controlling for year of discharge, ZIP code median income, distance to closest high-mortality hospital, and distance to closest other hospital. Odds ratios from the logit models were converted to relative risk ratios. CI is confidence interval.

^a Percentages represent the percentage of patients in markets categorized as low, medium, or high who were admitted to high-mortality hospitals. Thus, 74,073 is 39 percent of the total white patients in markets with low hospital segregation (total = 188,900, not shown).

EXHIBIT 3

Proportion Of Patients Admitted To A Hospital Other Than The Closest Hospital Or Admitted To A High-Mortality Hospital, Among Patients For Whom The Closest Hospital Was A Low-Mortality Hospital Or Who Resided Within Two Miles Of A Low-Mortality Hospital, 2000–2005

	Proportion of patients for whom closest hospital was not categorized as high mortality		Of patients residing closest to hospitals not categorized as high mortality, proportions of patients admitted to			
	White (n = 585,983)	Black (n = 68,115)	Hospital other than closest hospital		High-mortality hospital	
			White (n = 363,400)	Black (n = 35,505)	White (n = 363,400)	Black (n = 35,505)
Overall	62%	52%	43%	50% ****	12%	21% ****
Hospital segregation						
Low	57	53	40	41 ****	14	15
Medium	60	51	46	54 ****	12	22 ****
High	69	52	44	60 ****	9	27 ****
	Proportion of patients residing within 2 miles of a hospital not categorized as high mortality		Of patients residing within 2 miles of a hospital not categorized as high mortality, proportions of patients admitted to			
	White (n = 585,983)	Black (n = 68,115)	Hospital farther than 2 miles away		High-mortality hospital	
			White (n = 180,675)	Black (n = 24,425)	White (n = 180,675)	Black (n = 24,425)
Overall	31%	36%	32%	36% ****	12%	25% ****
Hospital segregation						
Low	24	28	30	31	14	16 ****
Medium	29	32	34	34	12	23 ****
High	39	50	33	39 ****	11	34 ****

SOURCE: Authors' calculations using Centers for Medicare and Medicaid Services (CMS) Medicare Provider Analysis and Review (MedPAR) (Part A) data for 2000–2005.

p < 0.001