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# Disparities in Surgical 30-Day Readmission Rates for Medicare Beneficiaries by Race and Site of Care

Thomas C. Tsai, MD, MPH, E. John Orav, PhD, and Karen E. Joynt, MD, MPH
Department of Health Policy and Management (TCT, KEJ) and the Department of Biostatistics
(EJO), Harvard School of Public Health; Department of Surgery (TCT), Department of Medicine,
Cardiovascular Division (KEJ) and General Internal Medicine (EJO), Brigham and Women's
Hospital; and the VA Boston Healthcare System (KEJ), all in Boston, MA

# **Abstract**

**Objective**—To determine whether black patients have higher odds of readmission than white patients following major surgery, and to ascertain whether these disparities are related to where black patients receive care.

**Summary Background Data**—Racial disparities are known to exist for many aspects of surgical care. However, it is unknown if disparities exist in readmissions following a surgical procedure, an area which is becoming a prime focus for clinical leaders and policymakers.

**Methods**—Using national Medicare data from 2007-2010, we examined 30-day readmissions for patients undergoing coronary artery bypass grafting, pulmonary lobectomy, endovascular abdominal aortic aneurysm repair, open abdominal aortic aneurysm repair, colectomy, and hip replacement. The main outcome measure was risk-adjusted odds of all-cause 30-day readmission. We used multivariate logistic regression to determine if black patients had higher readmission rates than white patients, and if so, whether this effect was mediated by the hospitals at which patients received care, or by poverty.

**Results**—Black patients had higher readmission rates than white patients (14.8% vs. 12.8%, odds ratio [OR] 1.19; 95% confidence interval [CI], 1.16-1.22; p<0.001). Patients undergoing major surgery at minority-serving hospitals also had higher readmission rates (14.3% vs. 12.8%, OR 1.14, 95% CI 1.09-1.19; p<0.001). In multivariate analyses, black patients at minority-serving hospitals had the highest overall odds of readmissions (OR 1.34). White patients at minority-serving hospitals (OR 1.15) and black patients at non-minority-serving hospitals (OR 1.20) also had higher odds of readmission than the reference group of white patients at non-minority-serving hospitals. Racial disparities were mediated in part by poverty.

**Conclusions**—Among Medicare beneficiaries, black patients were more likely to be readmitted after hospitalization for surgical procedures. Since racial disparities in readmission rates are mediated both by patients' race and the hospital at which care is delivered, efforts at reducing

disparities should not only focus on race-based measures, but also should focus on improving outcomes of care at minority-serving hospitals.

## Keywords

readmission; quality improvement; disparity; race; surgery

### Introduction

Readmission following a hospitalization is an important clinical outcome that has implications for both quality and costs of care. Especially for surgical conditions, readmissions have become increasingly accepted as a measure of quality, as surgical complications have been closely linked to readmission rates. <sup>1-3</sup> Currently, little is known about racial disparities in readmissions following surgical procedures. Existing evidence would suggest there is reason for concern, as racial disparities are known to exist for many other surgical outcomes: black patients have higher mortality rates following major cardiovascular and cancer operations, <sup>4</sup> lower odds of undergoing curative surgery for cancer operations, <sup>5</sup> and a lower likelihood of undergoing limb salvage through revascularization before amputation. <sup>6,7</sup>

Unfortunately, despite several decades' awareness of the presence of racial disparities in the use of major procedures, efforts to reduce racial disparities for surgical care have been largely unsuccessful. This may be because our understanding of the cause of disparities is incomplete. One possibility is that site of care matters. For procedures with established volume-outcome relationships, black patients are more likely to receive care from low-volume hospitals and surgeons. Prior studies in the medical literature have shown that care for minorities is highly concentrated, and that hospitals serving a high proportion of minority patients may provide lower-quality care. Alternatively, surgical readmissions may be largely related to patient factors such as socioeconomic status, as has been argued in the medical literature.

The importance of quantifying and understanding racial disparities in readmissions following a surgical procedure is made even more salient as the Hospital Readmissions Reduction Program (HRRP) administered by the Centers for Medicare and Medicaid Services (CMS) expands to penalize hospitals with high readmission rates for vascular procedures and surgical care. In this context, understanding the differential contributions of race versus site of care to surgical readmissions is critically important to predicting the potential impact of these penalties on vulnerable populations. Further, understanding whether disparities are primarily due to race, site of care, or socioeconomics could help clinical leaders more effectively craft interventions to ameliorate them.

Therefore, in this study, we sought to answer three main questions. First, do racial disparities exist for surgical readmissions across a wide range of common surgeries? Second, if these disparities are present, are they primarily related to race, or are they primarily related to the hospitals at which care is received? Lastly, if racial disparities in surgical readmissions exist, are they mediated by the effect of poverty?

## **Methods**

#### Data

Medicare Provider Analysis Review (MedPAR) 100% files from 2007-2010 were used to examine all inpatient hospitalizations for Medicare fee-for-service beneficiaries aged 65 years or older with International Classification of Diseases, Ninth Edition (ICD-9) procedure codes corresponding to coronary artery bypass graft (CABG), pulmonary lobectomy, endovascular abdominal aortic aneurysm repair (EVAR), open abdominal aortic aneurysm repair (AAA), colectomy, or hip replacement (Appendix Table 1), which we selected because they were common and costly within the Medicare population. Patients discharged from federal hospitals (such as Veterans Affairs facilities) and hospitals outside the 50 U.S. states and Washington D.C. were excluded; no exclusions based on minimum procedural volume were applied. Patients with procedures occurring during December of each year were excluded because information on full 30-day follow-up was not available. Patient race was categorized based on self-report from the Medicare data, and patients' Medicaid status was determined using the state Medicaid buy-in variable. As has been convention in other studies, non-black patients were categorized as white. <sup>8,16,17</sup>

The 2010 American Hospital Association survey was used to identify hospital characteristics including size, teaching status, ownership, and location. Hospitals' Disproportionate Share Index (a marker of hospitals caring for the poor) was obtained from the Medicare Impact file. Hospitals' performance on quality measures was examined using publicly available Hospital Compare data, which contains a surgical process measure summary score based on the commonly accepted Surgical Care Improvement Project (SCIP), a set of best-practice guidelines.

#### **Identifying Minority-Serving Hospitals**

For each hospital in our dataset, the proportion of Medicare discharges for black patients was calculated. Hospitals in the highest decile were designated as minority-serving hospitals, and the other 90% were categorized as non-minority-serving. As a sensitivity analysis, alternative thresholds including the highest quartile were used; results were similar, so only results defining minority-serving as the top decile are presented.

#### Outcome

The primary outcome for this study was risk-adjusted odds of all-cause 30-day readmission, which was calculated using the Medicare data. Each patient's likelihood of readmission was adjusted using the Elixhauser risk-adjustment scheme, which is a validated tool developed by the Agency for Healthcare Research and Quality (AHRQ) to be used with administrative data (Appendix Table 2).

#### **Analysis**

All analyses were conducted at the patient level. Characteristics of black versus white patients and minority versus non-minority-serving hospitals were first compared using Wilcoxon tests for continuous data and chi-squared tests for categorical data. We first calculated unadjusted 30-day readmission rates for black versus white patients and for

patients at minority-serving versus non-minority-serving hospitals, using only patients surviving to discharge as the denominator.

Multivariate patient-level logistic regression models using a generalized estimating equation with independent correlations were then created to calculate risk-adjusted odds of readmission, accounting for clustering at the hospital level. Race and site of care were both included in the risk-adjusted model to evaluate the independent contributions of each predictor to 30-day readmissions. The type of surgical procedure was also included in the multivariate logistic regression models to adjust for potential differences in procedure rates for black and white patients.

Patients were then categorized into four analytic groups: black patients at minority-serving hospitals, white patients at minority-serving hospitals, black patients at non-minority-serving hospitals. White patients at non-minority-serving hospitals. White patients at non-minority-serving hospitals served as the reference group. We then ran three separate models examining the relationships between these four analytic groups and risk-adjusted odds of 30-day readmission: the Risk-Adjusted Model adjusts for patient comorbidities only, the Quality-Adjusted Model additionally adjusts for hospital quality using the HQA surgical score, and the Poverty-Adjusted Model adjusts for individual Medicaid status to evaluate if the effects of race were mediated by poverty.

#### Sensitivity Analyses

We performed several sensitivity analyses. Based on prior research demonstrating that black patients receive surgery at lower-volume hospitals than white patients, we conducted analyses adjusting for hospital volume. Because of concern that black and white patients might differ in their indications for certain procedures, we repeated our analyses limiting our patient population to those patients with the following procedure-specific diagnoses: patients with isolated CABG, lung cancer for pulmonary lobectomy, non-ruptured aneurysms for EVAR and AAA, and colon cancer for colectomy. In order to account for competing risks, and the possibility that differences in readmission rates for black patients were related to differential survival to discharge, we also repeated our analyses examining the composite outcome of 30-day death or readmission rather than readmission alone. To explore the robustness of our results, we explored alternate classifications of race by comparing black to white patients and excluding other minority patients. Additionally, given the known overlap between safety net and public hospitals with minority-serving hospitals, we also performed analyses defining site of care by safety net status and public ownership. For this set of analyses, we used the Disproportionate Share (DSH) index from the Medicare Impact file and defined the highest quartile of DSH index as safety net hospitals, in a similar methodology to existing literature.<sup>18</sup>

A two-sided p-value of less than 0.05 was considered to be significant. All statistical analyses were performed using Stata version 12 (StataCorp, College Station, Texas). This study was granted exemption by the Harvard School of Public Health Institutional Review Board.

## Results

#### Patient characteristics

Between 2007 and 2010, there were 1,508,402 admissions following the six index procedures of coronary artery bypass graft, pulmonary lobectomy, endovascular abdominal aortic aneurysm repair, open abdominal aortic aneurysm repair, colectomy, or hip replacement. Our analytic dataset comprised the 1,458,833 of patients who survived to discharge and were eligible for a potential readmission. 78,567 (5.4%) of these discharges were for black patients and 1,380,266 (94.6%) were for white patients. Black patients were younger, more likely to be female, and more often had medical comorbidities including congestive heart failure (7.2% vs. 6.6%), diabetes (28.0% vs. 18.2%), hypertension (68.6% vs. 59.9%), and chronic kidney disease (13.3% vs. 6.9%, Table 1). Black patients were also more likely to be Medicaid-eligible and have longer lengths of stay. 32.0% of black patients underwent procedures at minority-serving hospitals compared to 4.8% of white patients.

## **Characteristics of Minority and Non-Minority Serving Hospitals**

Of the 3,121 hospitals in our sample, 312 (10.3%) were classified as minority-serving hospitals. The median proportion of black patients at minority-serving hospitals was 37.7% compared to 3.0% for non-minority-serving hospitals. 60.7% of minority-serving hospitals were located in the South compared to 39.3% of non-minority-serving hospitals. Minority-serving hospitals were more likely to also be safety-net hospitals, with an average CMS-designated disproportionate share index of 0.41 compared to 0.22 for non-minority-serving hospitals (Table 2).

#### Readmissions by Race and Site of Care

Examining all discharges for the procedures of interest, the overall unadjusted readmission rate for all patients in our sample was 12.9%. Unadjusted readmission rates for black patients were 16.0% compared to 12.7% for white patients (p<0.001, Table 3), and unadjusted readmission rates for patients at minority serving hospitals were 15.3% compared to 12.7% for patients at non-minority serving hospitals (p<0.001).

When we created a single model adjusting for patient comorbidities, procedure type, and race, as well as site of care, we found that black patients had a risk-adjusted readmission rate of 14.8% compared to 12.8% for white patients (OR 1.19, 95% CI 1.16-1.22, p<0.001). Similarly, patients undergoing procedures at minority-serving hospitals had higher risk-adjusted readmission rates than those undergoing procedures at non-minority-serving hospitals (14.3% vs. 12.8%, OR 1.14, 95% CI 1.09-1.19, p<0.001).

When we categorized patients into four groups by race and site of care, using white patients at non-minority-serving hospitals as our reference group, we found that black patients at minority-serving hospitals had the highest odds of readmission (OR 1.34, 95% CI 1.28-1.42, p<0.001, Table 4). White patients at minority-serving hospitals (OR 1.15, 95% CI 1.09-1.20, p<0.001) and black patients at non-minority-serving hospitals (OR 1.20, 95% CI 1.16-1.23, p<0.001) also had higher odds of readmission than the reference group. Patterns for each of the individual procedures were similar to the overall analysis; for all procedures except for

pulmonary lobectomy, black patients at minority serving hospitals had the highest odds of readmission (Appendix Table 3).

## Hospital Quality, Poverty, and Readmissions

Adding hospital quality to the readmissions model, as measured by the Hospital Compare surgical quality measure, did not meaningfully change the odds of readmissions for any of the groups (Table 4). When we examined the association between poverty and readmissions, we found that patients eligible for Medicaid had an odds ratio of 1.38 (95% CI 1.35-1.40, p<0.001) for 30-day readmission. Adding poverty to our main models somewhat decreased the odds of readmission for black patients at both minority-serving (OR 1.25, 95% CI 1.19-1.32, p<0.001) and non-minority serving hospitals (OR 1.12, 95% CI 1.09-1.15, p<0.001), yet both race and site of care remained independent predictors of increased odds of readmission. Odds of readmission for white patients were unchanged when Medicaid eligibility was added to the model (OR 1.14, 1.09-1.20, Table 4).

#### Sensitivity Analyses

Adjusting for hospital volume (Appendix Table 4) and including patients based on specific diagnoses in addition to procedure codes to ensure homogenous samples (Appendix Table 5) did not quantitatively change the results. In order to assess for competing risks and to determine if the effects seen were due to differential survival to discharge, we further examined odds of either 30-day death or readmission as our outcome; the overall patterns were similar but with an even greater magnitude, with black patients at minority-serving hospitals again having the highest odds of readmission or death (OR 1.63, 95% CI 1.51-1.77, p<0.001, Appendix Table 6). Adding hospital characteristics to our models did not meaningfully impact the results (Appendix Table 7). When we reran analyses comparing black patients and white patients without including the non-black patients in the white category, the overall results were identical, Lastly, we explored alternate definitions of minority-serving hospitals by performing multivariate regressing using the hospital levelcharacteristics of safety net status and public ownership. The overall patterns were similar in safety net hospitals with black patients (OR 1.30, 95% CI 1.25-1.36, p<0.001) having the highest odds of readmission (Appendix Table 8). Site of care as determined by public ownership did not mediate racial disparities.

## **Discussion**

We found that black patients had higher odds of 30-day readmission than white patients following a discharge for a surgical procedure. This disparity was related to the independent impact of race as well as to the site of care where patients underwent their surgery. The effects persisted even when accounting for hospital quality and poverty, as measured by Medicaid eligibility.

The mechanisms underlying the disparities we found are likely complex. The fact that both race and site of care were independent predictors of readmission suggest that both patient-level and hospital-level factors are important to consider when trying to understand racial disparities in this and other health outcomes. Black race was associated with a higher

readmission rate; black patients may have received poorer-quality care in the hospital than their white counterparts, \$11,19,20\$ or they may have had worse access to important resources in the outpatient setting that might help prevent readmissions. \$21\$

We also found that hospitals serving a high proportion of minority patients had higher readmission rates for both their black patients and their white patients, suggesting that hospital factors are also important in readmissions. These hospitals may differ structurally from those with fewer minorities; however, adjusting for hospital characteristics such as teaching status, size, ownership, and region did not qualitatively change our results. Similarly, adjusting for measured hospital quality or hospital volume did not explain our findings. This suggests that other, unmeasured differences between the two types of hospitals may be linked to outcomes. One such difference may be a differential quality of transitional care between these two types of hospitals; however, the evidence that high-quality transitional care can prevent readmissions is mixed.<sup>22-24</sup> Another possibility is that the differences we see between minority-serving and non-minority-serving hospitals are due to community factors such as the availability of primary care and other post-discharge resources.

We found that poverty partially mediated the racial disparities in our study. Adjusting for Medicaid eligibility at the patient level diminished the differences in readmission rates somewhat for black patients, though it had no significant impact for white patients. Socioeconomic status has been shown to be linked to worse surgical outcomes<sup>25,26</sup> as well as lower healthcare utilization.<sup>27</sup> Our study adds the additional insight that poor, black patients at minority-serving hospitals represent the apex of vulnerability, and suggests this population should be of special emphasis in efforts to reduce disparities through increased access to care as well as targeted discharge planning.

While outcomes such as perioperative mortality have been well-studied, only a limited literature exists examining racial disparities in readmissions for surgical patients. <sup>28</sup> Prior studies examining racial disparities in medical discharges similarly reported that black patients had higher readmission rates than white patients, and our findings deepen the insights gained from this prior work. <sup>17,29</sup> For several major surgical procedures, including major cancer operations, <sup>4,30</sup> vascular surgery, <sup>6,11,31</sup> and CABG, <sup>32</sup> black patients have been shown to have worse outcomes than white patients. Recent studies have also demonstrated that in segregated areas, black patients more often receive care at low-quality institutions. <sup>33</sup> Our study extends these findings to disparities in readmission rates, another important clinical outcome.

There are limitations to our study. We used administrative data for risk adjustment; although we used a standard and widely-accepted methodology, our models may nevertheless not fully account for variations in comorbidities and illness severity across racial and hospital groups. We lacked data on discharge planning and the use of specific care transitions practices across the hospitals and could not assess if this contributed to our observed results. Because we used Medicare data, our findings are limited to patients over the age of 65 and may not be applicable to other patient populations. As with all observational studies, we could not assess whether the relationships we found in our study were causal or only

correlative. Further research using clinical databases or qualitative methods may be needed in order to fully explore the mechanisms that may underlie the disparities observed in our study.

In summary, among elderly Medicare beneficiaries, black patients were more likely to be readmitted after hospitalization following surgical procedures. Since racial disparities in readmission rates are mediated by both patients' race and the hospital at which care is delivered, efforts at reducing disparities should not only focus on race-based measures, but also should focus on improving outcomes of care at minority-serving hospitals.

# **Supplementary Material**

Refer to Web version on PubMed Central for supplementary material.

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Table 1

Characteristics of Black and Non-Black Patients Undergoing Major Surgery Legend:

	Black (n=78,567)	White (n=1,380,266)	P- value
AGE, median (IQR)	74 [69, 80]	76 [70, 82]	< 0.001
SEX			
Male	41.5%	45.9%	< 0.001
COMORBIDITIES			
Congestive Heart Failure	7.2%	6.6%	< 0.001
Diabetes without complications	24.9%	16.5%	< 0.001
Diabetes with complications	3.1%	1.7%	< 0.001
Hypertension	68.6%	59.9%	< 0.001
Chronic Kidney Disease	13.3%	6.9%	< 0.001
Chronic Pulmonary Disease	14.8%	17.8%	< 0.001
Depression	2.3%	5.2%	< 0.001
Obesity	7.1%	5.3%	< 0.001
Medicaid Eligible	30.7%	10.3%	< 0.001
Discharged from Minority-Serving Hospital	32.0%	4.8%	< 0.001
Length of Stay (Days)	9.8	7.5	< 0.001
PROCEDURE			
CABG	19.6%	20.0%	0.009
Lobectomy	3.7%	3.4%	< 0.001
EVAR	4.3%	5.4%	< 0.001
AAA	1.2%	1.6%	< 0.001
Colectomy	34.3%	21.9%	< 0.001
Hip Replacement	36.8%	47.7%	< 0.001

 $AAA = abdominal\ aortic\ aneurysm;\ CABG = coronary\ artery\ bypass\ grafting;\ EVAR = endovascular\ aneurysm\ repair;\ IQR = interquartile\ range.$ 

 Table 2

 Characteristics of Minority-Serving and Non-Minority-Serving Hospitals Legend:

	Minority Serving (n= 312)	Non-Minority Serving (n=2809)
HOSPITAL SIZE		
Small	16.4%	29.5%
Medium	58.0%	57.4%
Large	25.6%	13.1%
OWNERSHIP		
For-profit	21.5%	20.4%
Non-profit	54.2%	65.1%
Public	24.4%	14.6%
SETTING		
Urban	89.7%	91.9%
TEACHING STATUS		
Teaching Hospital	23.7%	7.2%
LOCATION		
Northeast	14.5%	16.2%
Midwest	18.7%	24.0%
South	60.7%	39.3%
West	6.1%	20.6%
ICU	77.6%	80.3%
Percentage Black, %	37.7 [30.5, 52.8]	3.0 [0.8, 7.9]
Disproportionate Share Index, %	0.41 [0.30, 0.55]	0.22 [0.16,0.31]
Percent Medicaid, %	21.9 [17.4, 32.1]	17.0 [11.3, 20.9]
Nurses per 1000 patient days	5.7 [4.6, 7.1]	6.8 [5.4, 8.7]
HQA Surgery Score	95.9 [92.7, 97.6]	96.3 [94.2, 97.7]

ICU = intensive care unit. HQA = Hospital Quality Alliance

 Table 3

 Risk-Adjusted Odds of 30-Day Readmission by Race and Site of Care Legend:

	No. of Patients	Unadjusted Readmission Rate	Adjusted Readmission Rate, Mean (95 % CI)	Adjusted Odds Ratio (95% CI)
RACE				
Black	78,567	16.0%	14.8% (14.5%, 15.1%)	1.19 (1.16, 1.22)
White	1,380,266	12.7%	12.8% (12.6%, 12.9%)	Ref
SITE OF CARE				
Minority-Serving Hospital	91,907	15.3%	14.3% (13.8%, 14.8%)	1.14 (1.09, 1.19)
Non-Minority-Serving Hospital	1,366,926	12.7%	12.8% (12.7%, 12.9%)	Ref

Readmission rate calculations include only patients surviving to discharge (1,458,833 patients) in denominator. Model adjusts for patient characteristics, procedure type, and simultaneously includes both race and site of care.

 Table 4

 Risk-adjusted Odds of 30-Day Readmission by Patient Groups Legend:

	Risk- Adjusted Model	P- value	Quality- Adjusted Model**	P- value	Poverty- Adjusted Model***	P- value
MINORITY- SERVING						
Black	1.34 (1.28, 1.42)	< 0.001	1.34 (1.27, 1.41)	< 0.001	1.25 (1.19, 1.32)	< 0.001
White	1.15 (1.09, 1.20)	< 0.001	1.14 (1.09, 1.20)	< 0.001	1.14 (1.09, 1.20)	< 0.001
NON- MINORITY SERVING						
Black	1.20 (1.16, 1.23)	< 0.001	1.20 (1.16, 1.23)	< 0.001	1.12 (1.09, 1.15)	< 0.001
White	Ref	Ref	Ref	Ref	Ref	Ref

<sup>\*</sup> Risk-adjusted model controls for age, sex, comorbidities, procedure, race, and site of care

<sup>\*\*</sup> Quality-adjusted model controls for variables in the risk-adjusted model plus HQA surgical score

<sup>\*\*\*</sup>Poverty-adjusted model controls for variables in risk-adjusted model plus patient-level Medicaid eligibility