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Race and timeliness of transfer for revascularization in patients with acute myocardial infarction

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Abstract

Objectives—Patients with acute myocardial infarction (AMI) who are admitted to hospitals without coronary revascularization are frequently transferred to hospitals with this capability. We sought to determine if the timeliness of hospital transfer and quality of destination hospitals differed between black and white patients.

Methods—We evaluated all white and black Medicare beneficiaries admitted with AMI at non-revascularization hospitals in 2006 who were transferred to a revascularization hospital. We compared hospital length of stay prior to transfer and the transfer destination's 30-day risk-standardized mortality rate (RSMR) for AMI between black and white patients. We used hierarchical regression to adjust for patient characteristics and examine within- and across-hospital effects of race on 30-day mortality and length of stay prior to transfer.

Results—A total of 25,947 (42%) white and 2,345 (37%) black patients with AMI were transferred from 857 urban and 774 rural non-revascularization hospitals to 928 revascularization hospitals. Median (IQR) length of stay prior to transfer was 1 day (1-3) for white patients and 2 days (1-4) for black patients ($p<0.001$). In adjusted models, black patients tended to be transferred more slowly than white patients, a finding due to both across-hospital and within-hospital effects. For example, within an given urban hospital black patients were transferred an additional 0.24 days (95% CI 0.03-0.44) later than white patients. Additionally, the lengths of stay prior to transfer for all patients at urban hospitals increased by 0.37 days (95% CI 0.28-0.47) for every 20% increase in the proportion of AMI patients who were black. These results were attenuated in rural hospitals. The RSMR of the revascularization hospital to which patients were ultimately sent did not differ between black and white patients

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Conclusions—Black patients are transferred more slowly to revascularization hospitals after AMI than white patients, resulting from both less timely transfers within hospitals as well as admission to hospitals with greater delays in transfer; however, 30-day mortality of the revascularization hospital to which both groups were sent to appeared similar. Race-based delays in transfer may contribute to known racial disparities in outcomes of AMI.

Keywords

Healthcare Disparities; Patient Transfer; Critical Care; Cardiovascular Diseases; Quality Indicators

Introduction

An extensive body of evidence documents racial and ethnic disparities in the patterns of cardiovascular care.[1-10] The majority of prior research into the root causes of disparities in cardiovascular care focused on the role of the individual practitioner, or how care within a hospital differs across race and ethnicity.[11, 12] Yet recent work demonstrates that the health care system, particularly the hospital, also contributes to racial and ethnic inequalities in cardiovascular care.[7, 13] Multiple studies illustrate that hospitals that disproportionately serve black patients have fewer resources and often provide worse care to all patients with acute myocardial infarction (AMI), regardless of race.[14, 15]

These issues may also play out in the interhospital transfer of patients with AMI, but this important process has never been examined in this light. Most hospitals lack the capacity to revascularize AMI patients, and 75,000 patients with AMI are admitted to such hospitals annually in Medicare alone.[16] Guidelines suggest that patients with ST-elevation MI should be transferred to a revascularization center early in their course, in many cases prior to admission.[17] In addition, most non-ST-elevation MI patients also likely benefit from prompt transfer to a revascularization center within 48 hours or upon failure of medical therapy, usually after an initial admission to the non-revascularization hospital.[18] Differential transfer patterns by race may therefore influence disparities in access to care and outcomes, and -- since many revascularized patients arrive for their procedure as transfers from another hospital – differential transfer may be responsible for many black patients receiving revascularization in hospitals with worse risk adjusted mortality.[13, 19] Several studies suggest that black patients may be less likely to be transferred to revascularization hospitals, and when transferred are more likely to be sent 48 hours after admission compared to white patients.[20-23] However, the magnitude of transfer delay (i.e. hours or days) is not clear, nor is the extent to which these differences in transfer timing are attributable to practice patterns within a hospital or across hospitals. Further, although it has been shown that potential transfer destinations vary widely in the quality of care that they provide,[13, 16] there has been no systematic study of racial differentials in *where* patients are sent.

Given the essential – and likely growing – role of interhospital transfer in the care of AMI patients, we sought to use this as a model system in which to understand the processes of care that may lead to cardiovascular disparities. We hypothesized that racial differences might be present in three distinct ways during the transfer process. First, we hypothesized that black patients would be transferred more slowly than white patients within any given hospital.[20-23] Second, we hypothesized that hospitals with a higher percentage of black patients would transfer all of their patients more slowly than those serving more predominantly white patient populations.[7] Third, we hypothesized that, once transferred, black patients would be transferred to hospitals with worse 30-day risk-standardized mortality rates than would white patients.[13, 19]

Methods

Study design, data sources and study population

We performed a retrospective cohort analysis utilizing all fee-for-service Medicare beneficiaries in the 2006 Medicare Provider Analysis and Review (MedPAR) files admitted with a new primary diagnosis of AMI, defined as ICD-9-CM code of 410.xx (excluding 410.x2, prior diagnosis of AMI). We defined revascularization hospitals as those that performed at least 5 coronary bypass grafting (CABG) and percutaneous coronary intervention (PCI) procedures during the year.[24, 25] For this analysis, we only included patients initially admitted to non-revascularization hospitals with at least 10 AMI admissions during the calendar year in order to allow more reliable estimates of our outcomes of interest. We excluded patients from hospitals that performed PCI but did not perform CABG because such facilities receive very few transfers from non-revascularization hospitals and have distinct rationales for transferring out patients, such as rescue CABG after failed PCI.[26]

We defined interhospital transfers as temporally adjacent hospitalizations in the same patient at two different facilities; the discharge day for the nonrevascularization hospital had to be the same or one day less than the admitting date of the revascularization hospital.[27, 28] Data on hospital geographic location and academic affiliation were obtained from the 2005 American Hospital Association (AHA) Annual Survey.[29] We defined hospitals as being an urban or rural facility based on metropolitan statistical area.

Race is recorded in Medicare's administrative files primarily using data provided to the Social Security Administration by self-report. The sensitivity of this variable for white and black persons is > 95% but considerably lower (<60%) for others.[30] Thus, we limited the analysis to patients self-identified as white or black. Socioeconomic data was obtained by linking patient ZIP code to the 2000 US Census.

We used 30-day risk-standardized mortality rates (RSMR) for AMI from publically available data for each hospital during 2006 on the website Hospital Compare.[31] Briefly, risk-adjusted mortality rates are calculated from Medicare inpatient and outpatient claims data using hierarchical regression models of each hospitals mortality rate.[32, 33] We calculated length of stay (LOS) as the total number of days spent in the transferring hospital prior to transfer.

We limited our analyses to AMI patients at hospitals in the 50 states and the District of Columbia. We also excluded those patients treated at nonrevascularization hospitals with incomplete data on facility characteristics (n=18).

Statistical analysis

To determine the association between race and the timeliness of transfer, we compared the adjusted mean differences in the LOS at the transferring hospital across race groups using linear mixed models.[34] Because we were interested in determining whether hospitals that serve greater proportions of black patients systematically transfer their patients more slowly, we partitioned the covariate for race into two components – a within-center component and an across-center component.[35] This partitioning allowed us to fit a conditional model using a random effects framework. The across-center component was a variable representing the proportion of AMI patients who are black (p_i) presenting to that particular hospital. Thus, all patients presenting to that hospital, regardless of race, have the same value for p_i. The within-center component is simply the individual's own racial group (x_{ij}) represented as a dichotomous indicator variable; we included this in the model as a group-mean-centered variable. Both variables were modeled simultaneously in a regression where LOS prior to transfer was the outcome. The coefficient for the across-center variable describes the mean

difference in LOS, regardless of an individual's race, for a unit change in the proportion of black patients with AMI between centers. The coefficient for the within-center variable describes the mean difference in LOS for black vs. white patients who are transferred from the same center.

To examine the association between race and the quality of transfer, we compared the adjusted mean RSMR at the revascularization hospital to which the patient was ultimately sent across race groups after decomposing the race variable into within- and across-center components as described above. We used linear mixed models with transferring hospital entered as a random effect.

All models were adjusted for age, gender, total volume of black or white AMI patients presenting to the transferring hospital, day of the week on date of admission, patient use of critical care services, and the ZIP code-level percent below poverty and median household income assigned to each patient, unless specified. Black versus white comparisons were stratified by urban/rural status of the transferring hospital by including an interaction term.

We performed several sensitivity analyses to determine the robustness of our findings to various assumptions. First, we limited the cohort to only patients who actually received a PCI or CABG at the receiving hospital (n=17,760). Second, we repeated the original RSMR analysis after limiting the cohort to patients who were transferred on the same day they presented with AMI (n=4,260).

Analyses were conducted using Stata 11 (StataCorp. College Station, TX). Tests of significance used a two sided $p \leq 0.05$. The Institutional Review Board for the University of Michigan approved the study.

Results

There were 61,799 white and 6,294 black patients admitted with AMI to 857 urban and 774 rural, non-revascularization hospitals in Medicare in 2006. Of these patients, 25,947 white (42.0%) and 2,345 black (37.3%) patients were transferred to revascularization hospitals ($p<0.001$). Baseline demographic characteristics for patients who were transferred to revascularization hospitals are presented in **Table 1**. Black patients were younger, more often male, and resided lower socioeconomic areas. Forty-seven percent of hospitals in the analysis were rural. The care of black AMI patients was highly concentrated. Only 13% of rural hospitals admitted more than five or more black patients with AMI during the one-year study period, and 26% of urban hospitals admitted five or more black patients with AMI. Additional hospital and aggregate patient characteristics for rural and urban hospitals are presented in **eTable 1** (Supplemental Digital Content).

Black patients had significantly longer mean and median lengths-of-stay in the sending hospital prior to transfer than white patients (**Table 2**). After multivariable adjustment, black patients tended to be transferred more slowly than white patients, a finding due to both within-hospital and across-hospital and effects. Within any given urban hospital, black patients were transferred an additional 0.24 days (95% CI 0.03-0.44) later than white patients. Further, urban hospitals where a greater proportion of admitted patients with AMI are black tended to transfer all patients more slowly, regardless of the race of the individual. The lengths of stay prior to transfer for all patients in these hospitals increased by 0.37 days (95% CI 0.28-0.47) for every 20% increase in the proportion of admitted AMI patients who were black. Rural hospitals did not exhibit an association between pre-transfer LOS and the proportion of admitted AMI patients who were black (0.08 days per 20% increase in % of AMI patients who are black, 95% CI −0.01-0.17); however, even within these rural

hospitals, statistically significant black vs. white differences persisted at the patient-level (0.23 days, 95% CI 0.05-0.41 for black versus white patients within a hospital).

These within- and across-hospital effects are additive, and can result in large differences in timing of transfer across race groups (**Figure**). For example, black patients presenting to an urban hospital where only 80% of AMI patients are black would, on average, be transferred 1.12 days later than a white patient presenting to an urban hospital where 20% of AMI patients are black.

On unadjusted analysis, there were no differences in the 30-day risk-standardized mortality rate (RSMR) at hospitals to which black and white patient transfers were sent to, whether comparing means (15.9% vs 15.9%, respectively, p=0.054) or across quintiles of RSMR (p=0.07) (**Table 2**). Adjusted marginal estimates for the RSMR were 15.7% (95% CI 15.6-15.8%) for black and 15.7% (95% CI 15.6-15.8%) for white patients. This result did not differ by the proportion of black patients(p=0.65) or by urban/rural status of the transferring hospital (p value for interaction = 0.076).

On sensitivity analysis, differences in LOS did not significantly change when the analysis was limited to only patients who were revascularized at the receiving hospital (**eTable 2**). There were also no consistent differences in RSMR across race groups when restricting the analysis to patients transferred on the day of presentation or to only those revascularized once transferred (**eTable 3**).

Discussion

Among Medicare beneficiaries in 2006, we found evidence for two of our three hypotheses about the mechanisms generating racial differentials in transfer patterns. We found that black patients admitted to non-revascularization hospitals were less likely to be transferred to revascularization hospitals. When transferred, black patients were transferred more slowly to revascularization hospitals than white patients, resulting from both differential transfer times within any given hospital and, more importantly, because hospitals that see a large proportion of black patients transfer all patients more slowly. These within and across hospital differences in the timing of transfer support our first two hypotheses. However, contrary to our third hypothesis, there were no systematic differences in the quality of the revascularization hospitals to which black or white patients were sent. Together these data suggest that within-hospital processes play a much less of a role in generating racial differentials, whereas differences between hospitals may be quite important.

Our work extends a new body of literature showing that differences between hospitals can play a critical role in maintaining racial differences in care – that is, that the differences in care between hospitals are in some cases substantially greater than the differences in care within a given hospital.[36-38] Several processes of care delivered to patients with AMI show broader racial differentials between rather than within hospitals.[7, 39] To our knowledge, our study is the first study that quantifies the differentials in interhospital transfer for percutaneous coronary intervention, and how hospitals may accentuate such differentials.[20-23] These findings have important implications for how we think about interventions to reduce racial disparities in cardiovascular care – they strongly argue that remediation focused on racism or individual providers will be limited in its ability to change population outcomes, even if it is able to fully achieve the salutary outcome of eliminating within hospital differences in treatment.

There are several potential explanations for the greater delays in transfer at hospitals serving larger minority populations.[40] Prior research indicates that hospitals caring for greater

proportions of black patients are more likely to care for Medicaid patients and have lower nurse-to-patient ratios.[41] Strapped by financial constraints, safety-net hospitals may forego development of a "quality improvement culture" or limit adoption of computer order entry or electronic medical records, infrastructure which may improve the quality of care.[42] Such factors may work in concert to reduce the quality of care delivered at these hospitals and may contribute to the rural/urban differences we observed. An appropriate next step in cardiovascular care is to characterize and address the organizational factors that allow such delays to exist and to determine the impact of these delays clinical outcomes.

Our study has several important limitations. First, we excluded patients of all races other than black or white. We also excluded enrollees participating in a Medicare advantage plan and other Medicare beneficiaries under 65 years. Because insurers outside of Medicare may orchestrate transfers with different economic or clinical incentives, we wanted to hold constant the effects of insurance in order to try to avoid confounding of race by insurance status.[43] Further work is needed to elucidate transfer patterns across race outside of Medicare. We were also unable to fully characterize the factors driving the transfer decision or the reasons why black patients were transferred less frequently (e.g. differential mortality prior to transfer, severity of AMI). Because we had minimal data about this decision making process, we focused on the downstream effects after the transfer was made. Finally, the valid comparison of whether or not to transfer black and white patients requires ensuring that other differences between black and white patients have been accounted for. We were unable to fully adjust for potential differences in the presenting symptoms, underlying risk of poor outcome, comborbitidies, and treatment preferences between black and white patients. The observed differences in transfer timing may reflect delayed transfer of black patients who would benefit from early revascularization or earlier transfer of white patients who subsequently received inappropriate revascularization. Subsequent analyses addressing our research questions should better address these limitations.

Conclusions

We determined that black patients who present to non-revascularization hospitals with AMI are transferred to revascularization hospitals more slowly than white patients. This delay operates particularly at the hospital level because black patients are more likely to be admitted to hospitals with greater delays in transfer. These results suggest that an important mechanism for population-level racial disparities may be that hospitals that disproportionally care for black patients may perpetuate racial differences in AMI treatment.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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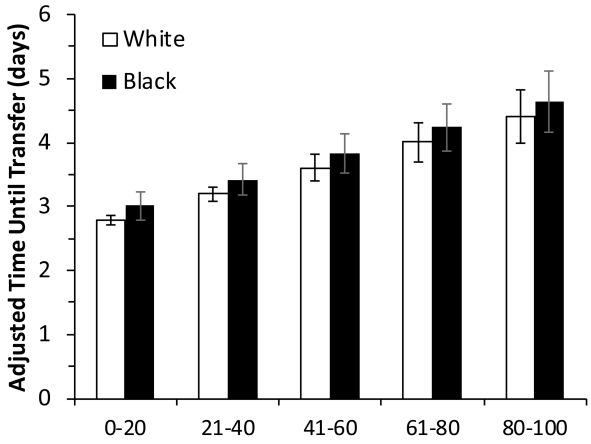
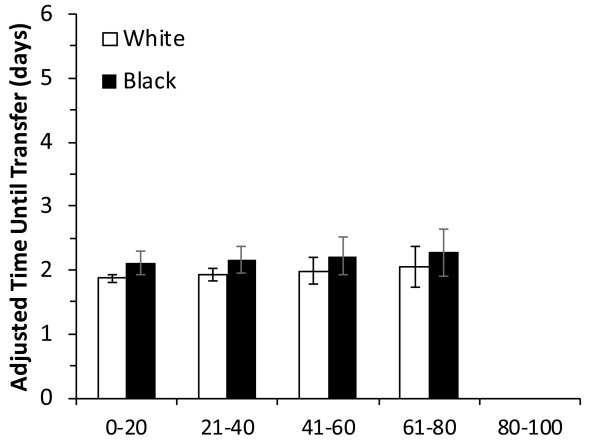
Panel A – Urban Hospitals



% of White Patients	92	6	1	0.5	0.1
% of Black Patients	41	24	13	10	12

Panel B – Rural Hospitals



% of White Patients	90	8	2	1	0
% of Black Patients	33	38	19	10	0

Figure.

Effect of race on within-center and across-center differences in the timeliness of transfer for urban and rural non-revascularization hospitals. Each panel presents the adjusted length of stay for black (black) and white (gray) patients at urban (Panel A) and rural (Panel B) non-revascularization hospitals prior to transfer as a function of the percent of all AMI patients presenting to that hospital who are black. The difference between the black and white bars represents the difference in adjusted length of stay for black and white patients presenting to the same hospital. Adjusted lengths of stay are presented when all other covariates in the model are set to their means.

Table 1

Characteristics of Medicare patients transferred from non-revascularization to revascularization hospitals

Characteristic	White (n=25947)	Black (n=2345)	p value
Age, years	75 (9)	70 (11)	<0.001
Female, %	55	47	<0.001
Critically ill, %	30	28	0.27
Distance to receiving hospital, miles, median (IQR)	26.2 (12-45)	16.1 (6.4-36)	<0.001
Socioeconomic characteristics			
Present to rural hospital %	42	32	<0.001
% below poverty*, mean (SD)	12 (7)	19 (10)	<0.001
Median household income*, thousands $US, mean (SD)	41.2 (15)	35.4 (13)	<0.001
% with less than high-school education*, mean (SD)	21 (10)	28 (11)	<0.001

IQR, interquartile range; SD, standard deviation

* data abstracted at level of ZIP code

Table 2

Unadjusted outcomes for white and black patients who are transferred to revascularization hospitals

Characteristic	White (n=25947)	Black (n=2345)	p value
AMI risk-standardized mortality rate at receiving hospital, mean (95% CI)	15.9 (15.8-15.9)	15.9 (15.8-16.0)	0.054
Quintile of AMI risk-standardized mortality rate at receiving hospital (%)			0.07
1 (10.8 -14.7%)	32.5	32.2	
2 (14.8 -15.7%)	19.5	19.6	
3 (15.8 -16.5%)	15.9	15.2	
4 (16.6 -17.5%)	16.3	18.4	
5 (17.6 - 22.1%)	15.9	14.5	
LOS at sending hospital, days			
median (IQR)	1 (1-3)	2 (1-4)	<0.001
mean (SD)	2.39 (2.8)	3.04 (3.6)	<0.001
LOS at receiving hospital, days			
median (IQR)	4 (2-8)	4 (2-8)	0.29
mean (SD)	6.28 (7.4)	6.70 (8.2)	0.02
PCI or CABG at receiving hospital, %	63	57	<0.001

AMI, acute myocardial infarction; CABG, coronary artery bypass graft; LOS, length of stay; PCI, percutaneous coronary intervention; Sd, standard deviation