Identifying Racial/Ethnic Disparities in Interhospital Transfer: an Observational Study

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BACKGROUND: Interhospital transfer (IHT) is often performed to provide patients with specialized care. Racial/ethnic disparities in IHT have been suggested but are not well-characterized.
OBJECTIVE: To evaluate the association between race/ethnicity and IHT.
DESIGN: Cross-sectional analysis of 2016 National Inpatient Sample data.
PATIENTS: Patients aged ≥ 18 years old with common medical diagnoses at transfer, including acute myocardial infarction, congestive heart failure, arrhythmia, stroke, sepsis, pneumonia, and gastrointestinal bleed.
MAIN MEASURES: We performed a series of logistic regression models to estimate adjusted odds of transfer by race/ethnicity controlling for patient demographics, clinical variables, and hospital characteristics and to identify potential mediators. In secondary analyses, we estimated adjusted odds of transfer among patients at community hospitals (those more likely to transfer patients) and performed subgroup analyses by region and primary medical diagnosis.
KEY RESULTS: Of 5,774,175 weighted hospital admissions, 199,015 (4.5%) underwent IHT, including 4.7% of White patients, compared with 3.9% of Black patients and 3.8% of Hispanic patients. Black (OR 0.83, 95% CI 0.78–0.89) and Hispanic (OR 0.81, 95% CI 0.75–0.87) patients had lower crude odds of transfer compared with White patients, but this became non-significant after adjusting for hospital-level characteristics. In secondary analyses among patients hospitalized at community hospitals, Hispanic patients had lower adjusted odds of transfer (aOR 0.89, 95% CI 0.79–0.98). Disparities in IHT by race/ethnicity varied by region and medical diagnosis.
CONCLUSIONS: Black and Hispanic patients had lower odds of IHT, largely explained by a higher likelihood of being hospitalized at urban teaching hospitals. Racial/ethnic disparities in transfer were demonstrated at community hospitals, in certain geographic regions and among patients with specific diseases.

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INTRODUCTION

Interhospital transfer (IHT) of patients is a common occurrence in modern health care. Medicare data suggests that 1.5% of patients,[1] including 45% of patients presenting with acute myocardial infarction, are transferred to a different hospital[2, 3] and that approximately 9% of all hospital admissions to tertiary care hospitals originated from another facility.[4] The potential benefits of IHT include improved access to necessary specialized care, "second opinions," and increased patient satisfaction.[5–7] Although the Emergency Medical Treatment and Active Labor Act (EMTALA) stipulates that patients should be transferred to (and must be accepted by) referral hospitals if they require specialized care not available at the original institution or when "medical benefits outweigh risks," it offers few concrete guidelines on when this process should be initiated. This lack of specific guidance on decision to transfer leaves IHT vulnerable to influence by non-clinical factors such as biases (implicit or explicit) by race/ethnicity, sex, insurance status, or other factors.

There is a robust body of evidence exposing healthcare disparities and inequities by race and ethnicity in the USA,[8, 9] across a range of metrics (outcomes, access, quality, satisfaction)[9] and specialties.[10–17] Whether racial and ethnic disparities in IHT contribute to gaps in healthcare access is less well studied. Prior IHT research,[1, 3, 18–29] including registry-based studies exploring factors associated with IHT,[1, 4, 24] has suggested influence of non-clinical factors, including race/ethnicity, on transfer practices. The most robust body of evidence derives from the cardiology literature,[3, 19, 20, 23, 26] in which minority patients have been shown to be less likely to be transferred to hospitals with revascularization capabilities. However, disparities by race and ethnicity in IHT for other common medical diagnoses have not been well-characterized.

For this study, we sought to determine if there are disparities by race/ethnicity in patients undergoing IHT for common primary medical diagnoses using nationally representative data.

METHODS

Data and Study Population

We performed a cross-sectional analysis of 2016 data from the National Inpatient Sample (NIS). This data set developed by the Agency for Health Care Research and Quality's Health Care Utilization Project (HCUP) is the largest publicly available all-payer inpatient healthcare database in the USA.[30]

Our cohort included all adult hospitalizations (≥ 18 years old) with acute myocardial infarction (AMI), congestive heart failure (CHF), arrhythmia, stroke, sepsis, pneumonia, and gastrointestinal bleeding (GIB). These diagnoses have been previously demonstrated to be the most common diagnoses during IHT.[1] Diagnoses were identified using the HCUP clinical classification software program, which groups diagnoses based on International Classification of Diseases, 10th edition (ICD-10) codes.[31] The Brigham and Women's Hospital institutional review board approved this study.

Outcomes, Predictors, and Covariates

The primary outcome of interest was transfer to another acute care facility as designated in the NIS dataset ("transfer out"). The primary predictor was race/ethnicity, a categorical variable defined in NIS as White, Black, Hispanic, Asian or Pacific Islander, Native American, and Other. If race and ethnicity are reported separately in state-level data that is compiled in NIS, ethnicity takes precedence.[32] We report here on the comparative results of Black and Hispanic race/ethnicity categories (compared with White) as we decided a priori to focus on these traditionally underserved racial/ethnic groups. We use the term disparity throughout to refer generically to differences in healthcare metrics between population subgroups.[33]

Covariates used for multivariable adjustment included both patient-level and hospital-level characteristics. Selection of covariates was based on prior literature on factors known to influence IHT,[1, 4, 21, 24] including other studies using NIS.[21, 24] Patient-level characteristics included age, sex, primary insurance (Medicare, Medicaid, private, self-pay, no insurance), median income of zip code by quartile, medical complexity based on All Patients Refined Diagnosis Related Groups (APR-DRG)–based risk of mortality,[34] and Elixhauser comorbidity index[35]; hospital-level characteristics included index hospital's location/teaching status (urban teaching, urban non-teaching, rural), ownership (public, private non-profit, private for-profit), region (Northeast, Midwest, South, West), and size (small, medium, or large as categorized based on number of hospital beds, location/teaching status, and geographic region).[36] Of note, hospitals' location and teaching status is a combined variable within NIS; rural hospitals are not split by teaching status because rural teaching hospitals are considered "rare."[37] Teaching hospitals are defined as those that have one or more Accreditation Council of Graduate Medical Education–approved residency programs, are members of the Council of Teaching Hospitals, or have a ratio of full-time equivalent residents to hospital beds greater than 0.25.[37]

We hypothesized a priori that several indicators of socioeconomic status, including primary insurance and median income of zip code, could mediate the association between race/ethnicity and likelihood of transfer (e.g., Black/Hispanic patients are more likely to be lower income and/or uninsured, and uninsured patients could be less likely to be transferred). Therefore, we considered these potential mediator variables as influencing the association between race/ethnicity and IHT and accounted for this in our analyses.

Statistical Analysis

All analyses were carried out using V.9.4 SAS statistical software (Cary, NC, USA). Complex survey procedures were used using HCUP-defined strata, clusters, and weights.

We used descriptive statistics to characterize the cohort. Rao-Scott chi-square testing was used to compare categorical variables by race/ethnicity; analysis of variance testing was used to compare continuous variables by race/ethnicity.

For our primary analysis, we first performed univariable logistic regression to calculate the unadjusted odds of IHT by race/ethnicity. We then performed a series of successive multivariable logistic regression models to estimate the association between race/ethnicity and IHT adjusting for covariates and accounting for potential mediators: first, we adjusted for all patient-level characteristics excluding potential mediator variables (primary insurance and median income of zip code); second, we added hospital-level characteristics to the model; lastly, we added the potential mediator variables to the model. Using the final multivariable model, which included all patient and hospital characteristics, we evaluated the independent association between each of the included variables and IHT.

Since most transfers originate from non-teaching hospitals,[1] we performed secondary analysis where we limited our analyses to patients hospitalized in rural and urban non-teaching hospitals. These hospitals are heretofore referred to as "community hospitals." Within this cohort, we performed multivariable regression models to obtain the adjusted odds of transfer by race/ethnicity overall and stratified by region (given known regional variation in transfer practices[1]) and stratified by diagnosis (to account for differential transfer practices and outcomes by diagnosis[1, 38]), adjusting for all other patient and hospital characteristics.

We performed a sensitivity analysis using 2012 data from the NIS to estimate if the associations demonstrated in the primary analysis were stable across years.

For all regression models, as all covariates included in the models had missing value rates of 3.8% or less, we excluded observations with missing values. We considered a priori hypotheses significant at a two-sided p value < 0.05. In subgroup analyses, we used a Bonferroni correction of the p value to account for multiple comparisons. As we tested 22 hypotheses, we rejected the null hypothesis for two-sided p value of 0.0023 (i.e., 0.05 ÷ 22). As IHT rates were low, we considered calculated odds ratios to be reasonable estimations of rate ratios.

RESULTS

Of the included 5,774,175 weighted individual admissions in the cohort, 71.9% were White, 13.8% Black, and 8.5% Hispanic; 3.8% had missing race data (Table 1). Among admissions without missing data on transfer status (99.9% of the cohort), 199,015 (4.5%) underwent transfer to another acute care facility.

There were several notable differences in transfer rates and patient- and hospital-level characteristics by race/ethnicity (Table 1). 4.7% of White patients underwent IHT, compared with 3.9% of Black patients and 3.8% of Hispanic patients. Notably, 7.5% of White patients had Medicaid for primary

Table 1 Rates of Transfer and Patient-/Hospital-Level Characteristics by Race/Ethnicity

Characteristic*,†	White (n = 3,996,836)	Black (n = 769,265)	Hispanic (n = 473,049)
Transferred, n (%)	142,270 (4.7)	23,300 (3.9)	14,985 (3.8)
Disease, n (%)			
AMI	462,950 (11.6)	70,215 (9.1)	50,085 (10.7)
CHF	531,304 (13.3)	151,705 (19.7)	60,895 (12.9)
Arrhythmia	543,885 (13.6)	69,955 (9.1)	44,785 (9.5)
CVA	418,810 (10.5)	103,405 (13.4)	51,005 (10.8)
Sepsis	1,270,714 (31.8)	239,040 (31.1)	179,280 (37.9)
Pneumonia	522,714 (13.1)	83,795 (10.9)	54,175 (11.5)
GIB	246,640 (6.2)	51,150 (6.6)	32,060 (6.8)
Patient-level			
Female sex, n (%)	1,944,358 (48.7)	391,930 (51.0)	224,715 (47.5)
Age, mean (SD)	69.9 (.04)	62.3 (.10)	63.3 (.21)
Insurance, n (%)			
Medicare	2,783,327 (69.7)	427,085 (55.6)	240,620 (50.9)
Medicaid	299,755 (7.5)	145,660 (19.0)	104,930 (22.2)
Private	717,999 (18.0)	131,845 (17.2)	82,635 (17.5)
Self-pay	99,115 (2.5)	38,770 (5.0)	32,470 (6.9)
No charge	7540 (0.2)	3850 (0.5)	3150 (0.7)
Zip median income, n (%)			
\$1–42,999	1,052,353 (26.8)	414,555 (55.0)	190,810 (41.2)
\$43,000–53,999	1,094,054 (27.8)	155,980 (20.7)	114,375 (24.7)
\$54,000–70,999	991,635 (25.2)	114,110 (15.1)	96,440 (20.8)
> \$71,000	792,655 (20.2)	69,550 (9.2)	60,980 (13.2)
APR-DRG mortality risk, n (%)			
Minor	713,714 (17.9)	154,025 (20.0)	105,000 (22.2)
Moderate	1,135,844 (28.4)	222,895 (29.0)	135,055 (28.5)
Major	1,316,984 (33.0)	244,040 (31.7)	139,930 (29.6)
Extreme	830,295 (20.8)	148,305 (19.3)	93,065 (19.7)
Elixhauser comorbidity index, mean (SD)	7.3 (0.04)	7.4 (0.06)	6.9 (0.07)
Index hospital-level			
Location/teaching status, n (%)			
Urban teaching	2,299,759 (57.5)	556,570 (72.4)	311,225 (65.8)
Urban non-teaching	1,187,328 (29.7)	162,070 (21.1)	146,210 (30.9)
Rural	509,749 (12.8)	50,625 (6.6)	15,615 (3.3)
Ownership, n (%)			
Public	392,433 (9.8)	100,650 (13.1)	63,950 (13.5)
Private non-profit	3,056,454 (76.5)	548,940 (71.4)	284,955 (60.2)
Private for-profit	547,949 (13.7)	119,675 (15.6)	124,145 (26.2)
Bedsize, n (%)‡			
Small	799,909 (20.0)	131,310 (17.1)	80,715 (17.1)
Medium	1,182,087 (29.6)	227,845 (29.6)	149,200 (31.5)
Large	2,014,840 (50.4)	410,110 (53.3)	243,135 (51.4)
Region, n (%)			
Northeast	772,365 (19.3)	125,195 (16.3)	69,815 (14.8)
Midwest	983,765 (24.6)	149,855 (19.5)	31,740 (6.7)
South	1,560,637 (39.0)	419,800 (54.6)	183,405 (38.8)
West	680,069 (17.0)	74,415 (9.7)	188,090 (39.8)

Includes patients without missing transfer data (99.9% of cohort). Weighted frequencies reported. Rates for "other" (2.4%) and "unknown" (3.8%) race not reported

**Columns may not add to 100% due to missing data*

†Differences by race/ethnicity were statistically significant at $p < 0.001$ for all characteristics

‡Hospital bedsize designation dependent on location/teaching status and geographic region[36]

AMI, acute myocardial infarction; APR-DRG, All Patients Refined Diagnosis Related Groups; CHF, congestive heart failure; CVA, cerebrovascular accident; GIB, gastrointestinal bleeding

insurance compared with 19.0% of Black patients and 22.2% of Hispanic patients. Nearly half of Black and Hispanic patients lived in zip codes whose median income was in the lowest quartile compared with 26.8% of White patients. 72.4% of Black patients and 65.8% of Hispanic patients were initially hospitalized in urban teaching hospitals compared with 57.5% of White patients.

In unadjusted analyses, compared with White patients, both Black (OR 0.83, 95% CI 0.78–0.89) and Hispanic (OR 0.81, 95% CI 0.75–0.87) patients had lower odds of IHT (Table 2). These associations persisted after adjusting for patient-level characteristics but excluding potential mediators. However, after adding hospital-level characteristics to the model, the associations became non-significant (Black: aOR 1.01, 95% CI 0.96–1.07; Hispanic: aOR 0.95, 95% CI 0.89–1.02, compared with White), with similar results observed after also including potential mediators in the last model.

In the full regression model including all covariates, we also noted that female sex was associated with significantly lower adjusted odds of IHT compared with men (aOR 0.79, 95% CI 0.78–0.81) (Table 3). Additionally, we found that, compared with patients with private insurance, patients with Medicaid (aOR 0.81, 95% CI 0.78–0.85) and self-pay (aOR 0.74, 95% CI 0.69–0.80) or no insurance (aOR 0.59, 95% CI 0.46–0.78) had lower adjusted odds of IHT. Compared with patients at the highest quartile of median income of zip code, those in the lower quartiles had lower adjusted odds of transfer.

In secondary analyses among patients hospitalized at community hospitals, Hispanic patients had 11% lower adjusted odds of transfer compared with White patients (aOR 0.89, 95% CI 0.79–0.98; $p = 0.033$), while there were no significant differences in odds of transfer for Black compared with White patients (Table 4). Within this secondary analysis cohort, upon stratification by region, Black patients hospitalized in the Midwest had statistically significant lower adjusted odds of transfer compared with White patients (aOR 0.73, 95% CI 0.61–0.88; $p = 0.0014$). Upon stratification by disease, Black patients with primary diagnosis of CHF had significantly lower adjusted odds of transfer compared with White patients (aOR 0.70, 95% CI 0.61–0.80; $p < 0.0001$), and Hispanic patients with GIB had significantly lower adjusted odds of transfer compared with White patients (aOR 0.59, 95% CI 0.44–0.80; $p = 0.0006$).

Our sensitivity analysis using the 2012 NIS data demonstrated similar results for the primary analysis.

DISCUSSION

In this nationally representative study of the association between race/ethnicity and IHT for patients hospitalized with common medical diagnoses, we found that Black and Hispanic patients had lower odds of transfer, primarily explained by differences in location of original hospitalization (i.e., Black and Hispanic patients were disproportionally initially hospitalized at urban teaching hospitals). Upon examination of the subset of patients hospitalized at community hospitals, and adjusting for other patient and hospital characteristics, Hispanic ethnicity remained significantly associated with lower odds of transfer. Among these patients, we observed differential adjusted odds of transfer by race within certain regions of the country and among patients with select primary diagnoses. We also found that women and "underinsured" patients (i.e., those with Medicaid or no insurance, compared with Medicare) had significantly lower adjusted odds of transfer. Though prior studies have demonstrated racial/ethnic disparities in various forms of access to medical care,[8, 9] this study is among the first to evaluate racial/ethnic disparities in hospital transfer among patients with primary medical diagnoses with the highest frequency of transfer.[1] Collectively, our results demonstrate a nuanced view of potential racial/ethnic disparities within IHT.

Although our crude results demonstrated significantly lower IHT rates among Black and Hispanic patients, these differences largely disappeared once adjusting for hospital characteristics. Our findings suggest that IHT practices are predominantly influenced by hospital characteristics and that racial/ethnic differences in transfer rates are largely explained by the fact that Black and Hispanic patients are more likely than White patients to initially present to urban teaching hospitals known to have lower rates of transfer.[1, 8] This explanation does not fully account for the persistent disparities observed among Hispanic patients hospitalized at community hospitals,

Table 2 Crude and Adjusted Odds of Transfer for Black and Hispanic Patients Compared with White Patients

	Crude	Patient-level adjustment, excluding mediators[†,‡]	Patient-/hospital-level adjustment, excluding mediators[‡,§]	Patient-/hospital-level adjustment, all variables
Race/ethnicity*	OR (95% CI)	aOR (95% CI)	aOR (95% CI)	aOR (95% CI)
Black	0.83 (0.78–0.89)[‖]	0.82 (0.77–0.88) [‖]	1.01 (0.96–1.07)	1.05 (0.99–1.13)
Hispanic	0.81 (0.75–0.87)[‖]	0.80 (0.74–0.87) [‖]	0.95 (0.89–1.02)	1.00 (0.93–1.08)

**Reference category = White*
[†]Patient-level characteristics include age, sex, primary insurance, zip code median income, APR-DRG mortality risk, and Elixhauser comorbidity index
[‡]Potential mediator variables include insurance and zip code median income
[§]Hospital-level characteristics include location/teaching status, ownership, bedsize, and region
[‖]$p < 0.001$
aOR, adjusted odds ratio; APR-DRG, All Patients Refined Diagnosis Related Groups; CI, confidence interval; OR, odds ratio

Table 3 Adjusted Odds of Transfer After Adjustment for Patient-/Hospital-Level Characteristics

Characteristics	aOR (95% CI)*	*p* value
Patient-level		
Race/ethnicity		
White	Ref	
Black	1.05 (0.99–1.13)	0.39
Hispanic	1.00 (0.93–1.08)	0.93
Female	0.79 (0.78–0.81)	< 0.001
Age, per additional year	0.99	< 0.001
Insurance		
Private	Ref	
Medicare	0.90 (0.87–0.94)	
Medicaid	0.81 (0.78–0.85)	< 0.001
Self-pay	0.74 (0.69–0.80)	< 0.001
No insurance	0.60 (0.46–0.78)	< 0.001
Zip code median income		
$1–42,999	0.81 (0.75–0.86)	< 0.001
$43,000–53,999	0.88 (0.83–0.94)	< 0.001
$54,000–70,999	0.91 (0.86–0.97)	0.0024
> $71,000	Ref	
Elixhauser comorbidity index, per unit increase	0.99	< 0.001
APR-DRG mortality risk		
Minor	Ref	
Moderate	1.32 (1.27–1.36)	< 0.001
Major	1.86 (1.79–1.93)	< 0.001
Extreme	2.96 (2.82–3.10)	< 0.001
Index hospital-level		
Location/teaching status		
Urban teaching	Ref	
Urban non-teaching	2.18 (2.03–2.35)	< 0.001
Rural	4.81 (4.45–5.20)	< 0.001
Ownership		
Public	Ref	
Non-profit	0.85 (0.78–0.92)	< 0.001
For-profit	0.91 (0.83–1.01)	0.074
Bedsize		
Small	Ref	
Medium	0.62 (0.58–0.66)	< 0.001
Large	0.34 (0.31–0.36)	< 0.001
Region		
Northeast	Ref	
Midwest	0.63 (0.58–0.69)	< 0.001
South	0.56 (0.51–0.62)	< 0.001
West	0.65 (0.59–0.71)	< 0.001

**Adjusted for all patient-/hospital-level characteristics*
aOR, adjusted odds ratio; APR-DRG, All Patients Refined Diagnosis Related Groups; CI, confidence interval

Table 4 Adjusted Odds of Transfer from Community Hospitals for Black and Hispanic Patients in Subgroup Analyses

	Black		Hispanic	
Subgroups	aOR (95% CI)	*p* value	aOR (95% CI)	*p* value
All patients	0.97 (0.92–1.04)	0.41	0.89 (0.79–0.98)	0.033‡
Region*				
Northeast	0.91 (0.74–1.12)	0.36	0.80 (0.58–1.09)	0.16
Midwest	0.73 (0.61–0.88)	0.0014‡	0.78 (0.61–0.99)	0.041
South	0.98 (0.89–1.08)	0.67	0.80 (0.66–0.98)	0.034
West	1.32 (1.09–1.60)	0.0048	1.11 (0.95–1.31)	0.19
Disease†				
AMI	1.13 (0.98–1.31)	0.11	1.20 (0.97–1.47)	0.086
CHF	0.70 (0.61–0.80)	< 0.001‡	0.75 (0.62–0.91)	0.0032
Arrhythmia	1.15 (0.97–1.37)	0.087	0.73 (0.57–0.94)	0.016
CVA	1.15 (0.97–1.36)	0.11	0.93 (0.75–1.15)	0.49
Sepsis	0.96 (0.86–1.07)	0.43	0.83 (0.72–0.96)	0.012
Pneumonia	0.84 (0.71–1.00)	0.045	0.91 (0.73–1.15)	0.44
GIB	0.98 (0.79–1.21)	0.86	0.59 (0.44–0.80)	0.0010‡

Reference category = White
**Reported odds ratios adjusted for all patient-level characteristics and index hospital bedsize and ownership*
†Reported odds ratios adjusted for all patient-level characteristics and index hospital bedsize, region, and ownership
‡Denotes statistical significance at p value < 0.05 for all patients and < 0.0023 for subgroup analyses
AMI, acute myocardial infarction; aOR, adjusted odds ratio; CHF, congestive heart failure; CI, confidence interval; CVA, cerebrovascular accident; GIB, gastrointestinal bleeding

i.e., at hospitals more likely to transfer patients.[1] Though much of the limited existing literature on IHT and race/ethnicity is focused on Black versus White patients, other studies have also demonstrated lower transfer rates among Hispanic patients for select conditions that often require transfer to receive specialty care.[24, 25, 39, 40] Our findings therefore highlight that such disparities likely persist among a broader population of Hispanic patients with the medical conditions included in this study.

Among patients admitted to community hospitals, our results additionally suggest disparity in transfer by race/ethnicity within select regions in the country, and among patients with select diagnoses. These findings were discovered in our subgroup analyses and therefore should be considered exploratory. Regional variations in IHT practices have been previously described,[1, 18, 25] but it is unclear why such variations would confer racial/ethnic disparities in transfer. Limited existing literature on disease-specific IHT is primarily focused on IHT of patients with AMI, largely demonstrating that Black patients who initially present to hospitals without revascularization capabilities are less likely to be transferred to hospitals with revascularization capabilities.[20, 23, 26] There is also suggestion of lower transfer rates for Black and Hispanic patients hospitalized with sepsis[25] and for Hispanic patients with select conditions (as described above)[24, 25, 39, 40] compared with White patients. Interestingly, our results did not corroborate the differences in transfer rates among patients hospitalized with AMI seen in the existing literature on this topic. This may be explained by the fact that, over time, as percutaneous intervention (PCI) has become more widely available, not only has need for transfer declined overall, but well-defined criteria for who to transfer may have ameliorated previously described disparities. It is also possible that the NIS lacks availability of essential confounders, e.g., hospital availability of cardiac catheterization services,[30] which were adjusted for in other evaluations. For diseases such as CHF and GIB, where there are less established criteria for transfer than for AMI, the decision to transfer is potentially more discretionary and therefore more prone to bias, which is prevalent in many other aspects of health care.[41, 42]

Our results also demonstrated that patients with underinsurance and patients residing in zip codes with lower median income had lower adjusted odds of IHT, suggesting additional disparity by socioeconomic status, which is commonly described in other aspects of healthcare access.[8, 43, 44] Several previous studies have demonstrated that underinsurance is associated with lower rates of transfer similar to our results,[1, 3, 21, 24, 26] while others have demonstrated underinsurance is associated with higher rates of transfer.[18, 27–29, 39, 45–52] Notably, the latter studies primarily involve patient transfers within the emergency room rather than for inpatients, which arguably confers disparate financial risk to hospitals (i.e., hospitals may be incentivized to transfer patients prior to admission to avoid being responsible for potentially lower reimbursement rates for services provided).[21] These incentives may be effectively reversed for patients that are already admitted to the hospital. Nevertheless, in our study, there was little change in the association between race/ethnicity and transfer after accounting for socioeconomic variables in our successive analyses, making this explanation less likely to account for the observed associations between race/ethnicity and transfer.

Thus, based on our results, there appear to be residual racial/ethnic disparities in IHT among select patients hospitalized at community hospitals after accounting for differences in location of hospitalization and socioeconomic status. While our study cannot explain the underlying reasons driving these observed disparities, we offer several hypotheses. One possibility is that the observed disparities are due to bias among providers that influence the decision to transfer, as has been demonstrated in other aspects of health care.[41, 42, 53] This is also suggested by our findings that women had significantly lower odds of transfer than men, indicating the potential existence of gender biases in addition to those pertaining to race/ethnicity. Second, it is possible that Black and Hispanic patients are less likely to request transfer. Transfer is frequently initiated by patient or family member request rather than medical necessity alone.[7] However, Black and Hispanic patients may have more comfort with receiving care at familiar hospitals,[54] less comfort with requesting transfer due to mistrust in the healthcare system,[55] or less able to request transfer due to language barriers. Third, it is possible that these results are partially or solely reflective of unmeasured confounding, as discussed below under *Limitations*. Lastly, it should be emphasized that IHT is a complex process with many factors that influence decision-making. Therefore, any observed disparities are most likely due to the interplay of the above possible explanations. Indeed, health inequities by race and ethnicity are attributable to multiple factors.[8, 56–58]

It should also be noted that, while this study describes *disparities* in IHT by race/ethnicity, we did not examine clinical outcomes of these patients. Existent literature suggests that, in select patients, transfer is associated with worse clinical outcomes including greater mortality, longer length of stay, and greater costs.[4, 24, 38] Therefore, these observed disparities may paradoxically protect the affected patient groups from worse outcomes. Even if this is the case, it does not justify the differential management of patients based on non-clinical factors and points toward potential health *inequities*, or differences in treatment rooted in systematic racial, economic, and social injustice.[8, 33] Moreover, some transfers are clearly justified and associated with improved outcomes, and depriving certain patient populations of these benefits likely has adverse consequences.[38]

This study is subject to several limitations. First, although we used nationally representative data, administrative data is subject to potential inaccuracies in variable coding. Coding of race/ethnicity, Hispanic ethnicity in particular, is often fraught with inaccuracies.[59–61] Specific to the NIS data, the variable for "race" is used for race and ethnicity designations. Thus,

"Hispanic" patients included in this study were unable to identify as "Black" or "White," and therefore may consist of a heterogenous population. Second, we were unable to account for the reason for transfer, which is not documented in NIS. We assume that the majority of patients who undergo IHT do so to receive necessary care unavailable at their original hospital, but we recognize that transfer is also initiated based on provider and/or patient preference even if the original hospital is capable of caring for a patient's condition.[7, 62] As discussed, understanding the underlying reason for transfer may help explain our observed findings and should be examined in future research on this topic. Third, we assume that patients who underwent transfer to another acute care facility received additional care at the receiving hospital, though we cannot confirm that this occurred. Forth, the NIS dataset includes individual hospital admissions rather than individual patients. We were therefore unable to account for patients who were admitted more than once during the time period of the study, which we assume is a small proportion of included hospitalizations. Fifth, by using a Bonferroni correction to account for multiple comparisons in the subgroup analyses and minimize type I error, we may have compromised power and increased type II error. Our odds ratio estimations could serve as effect size estimates for power calculations in future research exploring these hypotheses. Lastly, as with any administrative dataset, we were unable to account for unmeasured confounders that may have influenced our observed associations, including factors that may justify differences in IHT by race/ethnicity.

To conclude, we identified disparities in IHT by race/ethnicity for common medical diagnoses. There were variations in these observed disparities by geographic region and primary diagnosis. Though there are several possible explanations for our observed results, given the known systemic biases that exist within our healthcare system, these findings emphasize the need for further investigation to clarify why such disparities exist and how they might be reduced to ensure equitable provision of care to all patients.

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Data Availability: *The study protocol, statistical code, and results are available from Dr. Shannon upon reasonable request. The full dataset is available at https://www.hcup-us.ahrq.gov/tech_assist/centdist.jsp.*

Compliance with Ethical Standards:

The Brigham and Women's Hospital institutional review board approved this study.

Conflict of Interest: *The authors declare that they do not have a conflict of interest.*

REFERENCES

1. Mueller SK, Zheng J, Orav EJ, Schnipper JL. Rates, predictors and variability of interhospital transfers: a national evaluation. J Hosp Med. 2017;12(6):435-442.
2. Iwashyna TJ, Kahn JM, Hayward RA, Nallamothu BK. Interhospital transfers among Medicare beneficiaries admitted for acute myocardial infarction at nonrevascularization hospitals. Circ Cardiovasc Qual Outcomes. 2010;3(5):468-475.
3. Roe MT, Chen AY, Delong ER, et al. Patterns of transfer for patients with non-ST-segment elevation acute coronary syndrome from community to tertiary care hospitals. Am Heart J. 2008;156(1):185-192.
4. Sokol-Hessner L, White AA, Davis KF, Herzig SJ, Hohmann SF. Interhospital transfer patients discharged by academic hospitalists and general internists: characteristics and outcomes. J Hosp Med. 2016;11(4):245-250.
5. Iwashyna TJ. The incomplete infrastructure for interhospital patient transfer. Crit Care Med. 2012;40(8):2470-2478.
6. Gupta K, Mueller SK. Interhospital transfers: the need for standards. J Hosp Med. 2015;10(6):415-417.
7. Wagner J, Iwashyna TJ, Kahn JM. Reasons underlying interhospital transfers to an academic medical intensive care unit. J Crit Care. 2013;28(2):202-208.
8. In: Smedley BD, Stith AY, Nelson AR, eds. Unequal Treatment: Confronting Racial and Ethnic Disparities in Health Care. Washington (DC)2003.
9. 2017 National Healthcare Quality and Disparities Report. Agency for Healthcare Research and Quality. http://www.ahrq.gov/research/findings/nhqrdr/nhqdr17/index.html. Published 2017. Updated November 2018. Accessed April 22, 2019.
10. Bradley EH, Herrin J, Wang Y, et al. Racial and ethnic differences in time to acute reperfusion therapy for patients hospitalized with myocardial infarction. JAMA. 2004;292(13):1563-1572.
11. Kressin NR, Petersen LA. Racial differences in the use of invasive cardiovascular procedures: review of the literature and prescription for future research. Ann Intern Med. 2001;135(5):352-366.
12. Canto JG, Allison JJ, Kiefe CI, et al. Relation of race and sex to the use of reperfusion therapy in Medicare beneficiaries with acute myocardial infarction. N Engl J Med. 2000;342(15):1094-1100.
13. Grobman WA, Bailit JL, Rice MM, et al. Racial and ethnic disparities in maternal morbidity and obstetric care. Obstet Gynecol. 2015;125(6):1460-1467.
14. Lucas FL, Stukel TA, Morris AM, Siewers AE, Birkmeyer JD. Race and surgical mortality in the United States. Ann Surg. 2006;243(2):281-286.
15. Haider AH, Chang DC, Efron DT, Haut ER, Crandall M, Cornwell EE, 3rd. Race and insurance status as risk factors for trauma mortality. Arch Surg. 2008;143(10):945-949.
16. Cone DC, Richardson LD, Todd KH, Betancourt JR, Lowe RA. Health care disparities in emergency medicine. Acad Emerg Med. 2003;10(11):1176-1183.
17. Kimball MM, Neal D, Waters MF, Hoh BL. Race and income disparity in ischemic stroke care: nationwide inpatient sample database, 2002 to 2008. J Stroke Cerebrovasc Dis. 2014;23(1):17-24.
18. Ward MJ, Kripalani S, Zhu Y, et al. Role of health insurance status in interfacility transfers of patients with ST-elevation myocardial infarction. Am J Cardiol. 2016;118(3):332-337.
19. Hinohara TT, Al-Khalidi HR, Fordyce CB, et al. Impact of regional systems of care on disparities in care among female and Black patients presenting with ST-segment-elevation myocardial infarction. J Am Heart Assoc. 2017;6(10):e007122.
20. Cooke CR, Nallamothu B, Kahn JM, Birkmeyer JD, Iwashyna TJ. Race and timeliness of transfer for revascularization in patients with acute myocardial infarction. Med Care. 2011;49(7):662-667.
21. Hanmer J, Lu X, Rosenthal GE, Cram P. Insurance status and the transfer of hospitalized patients: an observational study. Ann Intern Med. 2014;160(2):81-90.
22. Usher MG, Fanning C, Fang VW, et al. Insurance coverage predicts mortality in patients transferred between hospitals: a cross-sectional study. J Gen Intern Med. 2018;33(12):2078-2084.
23. Popescu I, Vaughan-Sarrazin MS, Rosenthal GE. Differences in mortality and use of revascularization in black and white patients with acute MI admitted to hospitals with and without revascularization services. JAMA. 2007;297(22):2489-2495.

24. Hernandez-Boussard T, Davies S, McDonald K, Wang NE. Interhospital facility transfers in the United States: a nationwide outcomes study. J Patient Saf. 2017;13(4):187-191.
25. Tyler PD, Stone DJ, Geisler BP, McLennan S, Celi LA, Rush B. Racial and geographic disparities in interhospital ICU transfers. Crit Care Med. 2018;46(1):e76-e80.
26. Gurwitz JH, Goldberg RJ, Malmgren JA, et al. Hospital transfer of patients with acute myocardial infarction: the effects of age, race, and insurance type. Am J Med. 2002;112(7):528-534.
27. Nathens AB, Maier RV, Copass MK, Jurkovich GJ. Payer status: the unspoken triage criterion. J Trauma. 2001;50(5):776-783.
28. Huang Y, Kissee JL, Dayal P, Wang NE, Sigal IS, Marcin JP. Association between insurance and transfer of injured children from emergency departments. Pediatrics. 2017;140(4):e20163640.
29. Hamilton EC, Miller CC, 3rd, Cotton BA, Cox C, Kao LS, Austin MT. The association of insurance status on the probability of transfer for pediatric trauma patients. J Pediatr Surg. 2016;51(12):2048-2052.
30. Healthcare Cost and Utilization Project (HCUP): Overview of the National (Nationwide) Inpatient Sample (NIS). Agency for Healthcare Research and Quality. https://www.hcup-us.ahrq.gov/nisoverview.jsp. Published 2018. Updated August 2018. Accessed April 18, 2019.
31. Healthcare Cost and Utilization Project (HCUP): Beta Clinical Classification Software (CCS) for ICD-10-CM/PCS. Agency for Healthcare Research and Quality. https://www.hcup-us.ahrq.gov/toolssoftware/ccs10/ccs10.jsp. Published 2018. Updated October 2018. Accessed April 18, 2019.
32. Healthcare Cost and Utilization Project (HCUP): HCUP NIS Description of Data Elements: Race. Agency for Healthcare Research and Quality. https://www.hcup-us.ahrq.gov/db/vars/race/nisnote.jsp. Published 2018. Updated September 2018. Accessed April 19, 2019.
33. Braveman P. Health disparities and health equity: concepts and measurement. Annu Rev Public Health. 2006;27:167-194.
34. Hughes J. 3M HIS: APR DRG classification software—overview. Mortality Measurement. https://archive.ahrq.gov/professionals/quality-patient-safety/quality-resources/tools/mortality/Hughessumm.html. Published 2008. Accessed April 14, 2019.
35. Elixhauser A, Steiner C, Harris DR, Coffey RM. Comorbidity measures for use with administrative data. Med Care. 1998;36(1):8-27.
36. Healthcare Cost and Utilization Project (HCUP): HCUP NIS Description of Data Elements: Bedsize of hospital. Agency for Healthcare Research and Quality. https://www.hcup-us.ahrq.gov/db/vars/hosp_bedsize/nisnote.jsp. Published 2018. Updated September 2018. Accessed April 19, 2019.
37. Healthcare Cost and Utilization Project (HCUP): HCUP NIS Description of Data Elements: Location/teahcing status of hospital. Agency for Healthcare Research and Quality. https://www.hcup-us.ahrq.gov/db/vars/hosp_locteach/nisnote.jsp. Published 2018. Updated September 2018. Accessed April 18, 2019.
38. Mueller S, Zheng J, Orav EJ, Schnipper JL. Inter-hospital transfer and patient outcomes: a retrospective cohort study. BMJ Qual Saf. 2019;28(11):e1.
39. Morriss FH, Jr. Interhospital transfers of maternal patients: cohort analysis of Nationwide Inpatient Sample, 2011. Am J Perinatol. 2018;35(1):65-77.
40. Vaughan Sarrazin M, Limaye K, Samaniego EA, et al. Disparities in inter-hospital helicopter transportation for Hispanics by geographic region: a threat to fairness in the era of thrombectomy. J Stroke Cerebrovasc Dis. 2019;28(3):550-556.
41. FitzGerald C, Hurst S. Implicit bias in healthcare professionals: a systematic review. BMC Med Ethics. 2017;18(1):19.
42. Hall WJ, Chapman MV, Lee KM, et al. Implicit racial/ethnic bias among health care professionals and its influence on health care outcomes: a systematic review. Am J Public Health. 2015;105(12):e60-76.
43. Chetty R, Stepner M, Abraham S, et al. The association between income and life expectancy in the United States, 2001-2014. JAMA. 2016;315(16):1750-1766.
44. Health, income, & poverty: where we are & what could help. Health Affairs Health Policy Brief. October 4, 2018. Accessed April 30, 2019.
45. Babu MA, Nahed BV, Demoya MA, Curry WT. Is trauma transfer influenced by factors other than medical need? An examination of insurance status and transfer in patients with mild head injury. Neurosurgery. 2011;69(3):659-667; discussion 667.
46. Delgado MK, Yokell MA, Staudenmayer KL, Spain DA, Hernandez-Boussard T, Wang NE. Factors associated with the disposition of severely injured patients initially seen at non-trauma center emergency departments: disparities by insurance status. JAMA Surg. 2014;149(5):422-430.
47. Kao DP, Martin MH, Das AK, Ruoss SJ. Consequences of federal patient transfer regulations: effect of the 2003 EMTALA revision on a tertiary referral center and evidence of possible misuse. Arch Intern Med. 2012;172(11):891-892.
48. Koval KJ, Tingey CW, Spratt KF. Are patients being transferred to level-I trauma centers for reasons other than medical necessity? J Bone Joint Surg Am. 2006;88(10):2124-2132.
49. Missios S, Bekelis K. Nonmedical factors and the transfer of spine trauma patients initially evaluated at Level III and IV trauma centers. Spine J. 2015;15(9):2028-2035.
50. Rosenbaum S, Cartwright-Smith L, Hirsh J, Mehler PS. Case studies at Denver Health: 'patient dumping' in the emergency department despite EMTALA, the law that banned it. Health Aff (Millwood). 2012;31(8):1749-1756.
51. Thakur NA, Plante MJ, Kayiaros S, Reinert SE, Ehrlich MG. Inappropriate transfer of patients with orthopaedic injuries to a Level I trauma center: a prospective study. J Orthop Trauma. 2010;24(6):336-339.
52. Venkatesh AK, Chou SC, Li SX, et al. Association between insurance status and access to hospital care in emergency department disposition. JAMA Intern Med. 2019;179(5):686-693.
53. Dehon E, Weiss N, Jones J, Faulconer W, Hinton E, Sterling S. A systematic review of the impact of physician implicit racial bias on clinical decision making. Acad Emerg Med. 2017;24(8):895-904.
54. Jha AK, Orav EJ, Li Z, Epstein AM. Concentration and quality of hospitals that care for elderly black patients. Arch Intern Med. 2007;167(11):1177-1182.
55. Gamble VN. Under the shadow of Tuskegee: African Americans and health care. Am J Public Health. 1997;87(11):1773-1778.
56. Mays VM, Jones AL, Delany-Brumsey A, Coles C, Cochran SD. Perceived discrimination in health care and mental health/substance abuse treatment among Blacks, Latinos, and Whites. Med Care. 2017;55(2):173-181.
57. Juckett G. Caring for Latino patients. Am Fam Physician. 2013;87(1):48-54.
58. Lin MY, Kressin NR. Race/ethnicity and Americans' experiences with treatment decision making. Patient Educ Couns. 2015;98(12):1636-1642.
59. Filice CE, Joynt KE. Examining race and ethnicity information in Medicare administrative data. Med Care. 2017;55(12):e170-e176.
60. Zaslavsky AM, Ayanian JZ, Zaborski LB. The validity of race and ethnicity in enrollment data for Medicare beneficiaries. Health Serv Res. 2012;47(3 Pt 2):1300-1321.
61. Kressin NR, Chang BH, Hendricks A, Kazis LE. Agreement between administrative data and patients' self-reports of race/ethnicity. Am J Public Health. 2003;93(10):1734-1739.
62. Bosk EA, Veinot T, Iwashyna TJ. Which patients and where: a qualitative study of patient transfers from community hospitals. Med Care. 2011;49(6):592-598.