Hsuan Charleen (Orcid ID: 0000-0001-8720-2323)
Norton Edward (Orcid ID: 0000-0003-4555-0631)

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Racial and Ethnic Disparities in Emergency Department Transfers to Public Hospitals

Charleen Hsuan JD PhD,[1] David J Vanness PhD,[1] Alexis Zebrowski PhD,[2,3] Brendan G Carr MD,[2,3] Edward C. Norton PhD,[4,5] David G Buckler,[2] Yinan Wang MPP,[1] Douglas L. Leslie PhD,[6] Eleanor F. Dunham MD,[7] Jeannette A. Rogowski, PhD[1]

[1] Department of Health Policy & Administration, Pennsylvania State University
[2] Department of Emergency Medicine, Icahn School of Medicine at Mount Sinai
[3] Department of Population Health Science and Policy, Icahn School of Medicine at Mount Sinai
[4] Department of Health Management and Policy, University of Michigan School of Public Health
[5] Department of Economics, University of Michigan
[6] Department of Public Health Sciences, College of Medicine, Pennsylvania State University
[7] Department of Emergency Medicine, College of Medicine, Pennsylvania State University

Contact Information for Corresponding & Co-Authors
Charleen Hsuan, JD PhD (corresponding author)
601B Donald H. Ford Building
Penn State University
University Park, PA 16802
chsuan@psu.edu | 814-863-2859

David Vanness
501J Donald H. Ford Building
Penn State University
University Park, PA 16802
djv76@psu.edu | 814-863-7333

Alexis Zebrowski
555 West 57th Street
19th Floor, Room 19-94
New York, NY 10019
Alexis.Zebrowski@mountsinai.org | 212-824-8036

Brendan Carr
Mount Sinai Health System
CEO & President's Office
1 Gustave L. Levy Place, Box 1220
New York, NY 10029
Brendan.Carr@mountsinai.org | 212-659-8888

Edward Norton
M3108 SPHII
1415 Washington Heights
Ann Arbor, MI 48109
ecnorton@umich.edu | 734-615-5738

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David Buckler
555 W. 57th St
Room 19-94
New York, NY 10029
David.Buckler@mountsinai.org | 240-281-7488

Yinan Wang
Department of Health Policy and Administration
Penn State University
University Park, PA 16802
yuw415@psu.edu | 814-880-8286

Douglas Leslie
90 Hope Drive
Suite 2200
Hershey, PA 17033
dleslie@pennstatehealth.psu.edu | 717-531-7178

Eleanor Dunham
Department of Emergency Medicine
Penn State Hershey Medical Center
500 University Drive, PO Box 850
Hershey, PA 17033
edunham@pennstatehealth.psu.edu | 717-531-3781

Jeannette Rogowski, PhD
504U Donald H. Ford Building
Penn State University
University Park, PA 16802
jar1106@psu.edu | 814-865-6899

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Abstract

Objective. To examine racial/ethnic differences in emergency department (ED) transfers to public hospitals, and factors explaining these differences.

Data sources and Study Setting. ED and inpatient data from the Healthcare Cost and Utilization Project for Florida (2010-2019); American Hospital Association Annual Survey (2009-2018)

Study Design. Logistic regression examined race/ethnicity and payer on the likelihood of transfer to a public hospital among transferred ED patients. The base model controlled for patient and hospital characteristics, and year fixed effects. Models II and III added urbanicity and hospital referral region (HRR), respectively. Model IV used hospital fixed effects, which compares patients within the same hospital. Models V and VI stratified Model IV by payer and condition, respectively. Conditions were classified as emergency care sensitive conditions (ECSCs), where transfer is protocolized, and non-ECSCs. We reported marginal effects at the means.

Data Collection / Extraction Methods. 1,265,588 adults

Principal Findings. Black patients were more likely to be transferred to public hospitals compared to White patients in all models except ECSC patients within the same initial hospital (except trauma). Black patients were 0.5 to 1.3 percentage points (pp) more likely to be transferred to public hospitals than White patients in the same hospital with the same payer. In the base model, Hispanic patients were more likely to be transferred to public hospitals compared to White patients, but this difference reversed after controlling for HRR. Hispanic patients were -0.6pp to -1.2pp less likely to be transferred to public hospitals than White patients in the same hospital with the same payer.

Conclusions. Large population-level differences in whether ED patients of different races/ethnicities were transferred to public hospitals were largely explained by hospital market and the initial hospital, suggesting that they may play a larger role in explaining differences in transfer to public hospitals, compared to other external factors.

Keywords: 5-7

- Emergency Departments
- Transfers
- Public hospital
- Disparities
- Race and ethnicity

Abbreviations:

AHRQ = Agency for Healthcare Research & Quality; CCS = Clinical Classification Software for ICD-9-CM; CCS-R = Clinical Classification Software Refined (CCS-R) for ICD-10- CM; CPT = Current Procedural Terminology; ECSC = emergency care sensitive condition; ED = emergency department; EMTALA = Emergency Medical Treatment and Labor Act; HCUP = Healthcare Cost and Utilization Project; HRR = hospital referral region; PP = percentage point ; STEMI = ST-elevation myocardial infarction

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What is known on this topic

- Uninsured and Medicaid patients are more likely to be transferred from the emergency department than privately-insured patients
- Hispanic and Black patients are less likely to be transferred from the ED than patients who are White, although this varies by condition
- Little is known about whether there are disparities in where Black or Hispanic patients are transferred to or what factors may be most important in determining the transfer.

What this study adds

- Black non-Hispanic emergency department patients were more likely to be transferred to public hospitals than White non-Hispanic patients, even for patients within the same initial hospital and the same payer
- After accounting for market, Hispanic emergency department patients were less likely to be transferred to public hospitals than White non-Hispanic patients, even within the same initial hospital and the same payer
- Large population-level differences in whether emergency department patients of different races/ethnicities were transferred to public hospitals were largely explained by the hospital market and the initial hospital

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Introduction

Access to hospital-based emergency care is an important population health metric,[1] but it is not equitable. Emergency department (ED) capability and capacity vary geographically,[2-4] with patients in high racial/ethnic minority and low-income communities having less ED access because of closures[5-8] and crowded EDs,[9] resulting in lower access to advanced cardiac care,[10] certified stroke hospitals,[11-13] and trauma centers.[14] Transfers between hospitals can link disadvantaged communities to definitive care provided by hospitals in other areas. While the Emergency Medical Treatment and Labor Act (EMTALA) requires Medicare-participating hospitals to provide emergency care to all patients regardless of race/ethnicity, payer, or any non-clinical characteristics, its scope in relation to transfers is limited. Despite its initial purpose — to prevent hospitals from "dumping" disadvantaged patients on public hospitals — EMTALA does not require that patients with the same condition be transferred to the best, or even the same, receiving hospital. Yet, little research examines racial/ethnic disparities in ED transfers, specifically in differences in where patients are transferred, or what may drive disparities.

Previous literature on disparities in ED transfers has focused on whether there are payer-based differences in likelihood of transfer. Medicaid and uninsured patients are more likely to be transferred from the ED than privately-insured patients,[15-19] even when the initial hospital likely has capability to treat the condition.[17] Since Black and Hispanic patients are more likely to have Medicaid or be uninsured,[20] they may be more likely to experience ED transfers. While descriptive studies suggest no racial/ethnic difference in the likelihood of transfer,[16] Zachrison et al. (2022) found that Hispanic ED patients with acute ischemic stroke were less likely to be transferred than White patients, even though there was no difference in likelihood of presentation to an initial hospital with capability.[21] Hospitalized patients who are Black are less likely to have

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been transferred than patients who are White,[22-24] although the probability of inpatient transfer for patients who are Hispanic compared to White patients varies depending on condition.[24,25] In summary, prior research suggests that compared to privately-insured patients, Medicaid and uninsured patients are more likely to be transferred, while compared to White patients, Black and Hispanic patients are less likely to be transferred.

The purpose of this study was to examine whether race/ethnicity is associated with ED transfer destination. Specifically, we focused on racial/ethnic differences in transfers to public hospitals and potential explanations. We hypothesized that Black and Hispanic patients would be more likely to be transferred to public hospitals than White patients, and that these differences would be primarily due to differences in where patients initially present, as described in greater detail below.

Racial and ethnic differences in transfers to public hospitals may be important for three reasons. First, while not true for all public hospitals or conditions,[26] safety net hospitals[27-30] and public hospitals[31] on average score worse on public reporting, readmissions, and quality improvement metrics than non-public hospitals. Second, safety net hospitals are often overcrowded, and ED overcrowding is associated with adverse outcomes including higher mortality, both for ED patients[32-35] and inpatients in those hospitals.[36,37] Thus transfers to already-overburdened safety net hospitals might worsen patient outcomes, both for the transferred patient and for patients already at those safety net hospitals. Third, racial and ethnic differences in where patients are transferred – if not explained by geography, insurance, or condition -- may suggest a dual standard of treatment, particularly given the historical context of EMTALA and patient dumping. It might suggest that public hospitals are perceived to be the hospital of choice for racial/ethnic minoritized patients.

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Conceptual Framework

To better understand the potential source of racial disparities, we relied on the Hospital Transfer Network Equity–Quality (NET-EQUITY) conceptual framework, a framework we developed for understanding the equity of hospital transfer networks.[38] NET-EQUITY suggests that the structure of hospital transfer networks is influenced by internal and external factors. Internal factors include hospital culture, ownership,[15] and provider specialty, training, and experience. Hospitals also vary in the number of transfer partners.[39]

Four external factors that influence the structure of hospital transfer networks are the: sociocultural and physical/built environment; economic environment; provider environment; and regulatory environment. In this study, we examine first whether there are racial/ethnic differences in whether ED patients are transferred to public hospitals, and second, how the internal factors and first three external environments influence or mediate these differences. (**Figure 1**)

Sociocultural and Physical/Built Environment. The sociocultural and physical/built environment may influence whether there are differences in where patients are transferred.[40] For instance, initial hospitals are less likely to be in the most urban areas, while receiving hospitals are more likely to be in those areas.[39] Ambulances in rural areas may be reluctant to transfer long distances since that reduces availability.[41] Hospital markets may also influence disparities in transfer to public hospitals. For instance, markets may differ in the number of potential receiving hospitals and distance between potential receiving hospitals;[39] whether there are public hospitals; and capability of potential receiving hospitals.

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Economic Environment. The economic environment may influence the choice of receiving hospital. For instance, initial hospitals may transfer patients to different receiving hospitals based on patients' perceived or actual ability to pay,[42] or based on expected reimbursement rates, which are lower for uninsured and Medicaid patients than Medicare and privately-insured patients.[43] Receiving hospitals may be less likely to accept transfer patients if they have unfavorable insurance, particularly if the transfer is not one governed by EMTALA.[44]

Provider Environment. We define "provider" broadly to include both care providers within hospitals and hospitals themselves. It includes physicians' personal relationships, institutionalized preferences, and regionalization that influence the choice of receiving hospital. Hospitals may have routinized transfer procedures for certain conditions, including the choice of transfer partner.[45-47] Routinization of transfers may be more likely to occur for emergency care sensitive conditions (ECSCs),[48,49] which are "conditions for which rapid diagnosis and early intervention in acute illness or acutely decompensated chronic illness improve patient outcomes,"[50] such as ST-elevation myocardial infarction (STEMI), stroke, and major trauma. In this study, we examine differences in transfer to public hospitals for ECSCs and non-ECSCs, as well as certain ECSC and non-ECSC conditions.

Methods

We combined 2010-2019 all-payer ED and inpatient hospital discharge data for Florida, obtained from the Healthcare Cost and Utilization Project (HCUP) State Inpatient Databases and State Emergency Department Databases data, with American Hospital Association Annual Survey (2009-2018) hospital characteristic data, and median household income data for the

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patient ZIP code from the Area Health Resource File. We use pre-COVID-19 data due to fundamental difference in ED use and transfers during the acute phase of the pandemic.[51-53]

Our sample consisted of adult ED transfers from non-federal, general medical hospitals. Initial and receiving hospitals could be public or non-public. ED transfers were a new ED or inpatient visit at another hospital on the same or next day.[23,54-56] If there were multiple transfers, we included only the first transfer. Although there are alternative transfer definitions, including using disposition codes with timing,[15,17,39,57] we defined transfers using timing only to minimize bias. Sample bias may occur when defining transfers using disposition status if use of transfer disposition codes vary by payer (e.g. Medicare requires the code). Furthermore, using disposition excludes "indirect referrals,"[42] where patients are not formally transferred, but instead told at discharge to go to another hospital. At one urban public hospital, almost 20% of ED patients treated for orthopedic injuries were indirectly referred, and almost 90% of these patients were uninsured.[42]

We excluded visits by patients younger than age 18, who died during the transfer, and were transferred to receiving hospitals lacking ownership information. (**Appendix I**)

This project was approved as exempt by the Pennsylvania State University's Institutional Review Board. We report results using the STROBE checklist.

Variables

Our outcome was a binary indicator of hospital ownership; public hospital (city, county, or state-owned facility), versus a non-public hospital.

Our main predictors were race/ethnicity and primary payer, as coded in HCUP. Race/ethnicity was: White non-Hispanic, Black non-Hispanic, Hispanic, or Other/Missing.

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Asian/Pacific Islander was categorized as "Other" because of sample size. Payer was the expected primary payer: private/commercial, Medicare, Medicaid, uninsured, or Other/Missing. Medicare managed care (e.g., Medicare Advantage) and dual eligible patients were coded as Medicare.

The covariates were visit and hospital characteristics. Visit characteristics were: age, sex, race/ethnicity, payer, Charlson comorbidity index,[58-60] weekend visit indicator, and severity. We proxied severity using billing codes that correlate with triage levels,[61] creating a dichotomous variable for visits with codes suggesting more severe conditions (e.g. critical care services or more complex medical decision-making[62]). (**Appendix II**) The hospital characteristics were: academic status, hospital size (0-99, 100-299, 300-499, and 500+ beds), and urbanicity (truncated 2013 National Center for Health Statistics Urban-Rural Classification Scheme for Counties[63]).

Statistical Analyses

We compared visit and initial hospital characteristics across different racial/ethnic groups. We tested for race/ethnicity and payer differences in transfer patients using chi-squared and Kruskal-Wallis rank tests, as appropriate.

The study objective was to examine the extent to which internal and external factors influence racial/ethnic differences in ED transfers to public hospitals. We evaluated the extent to which accounting for the internal and external factors change the extent to which race/ethnicity predicts the likelihood of transfer to public hospitals. We began with a base model (*Model I*) that controlled for visit and initial hospital characteristics. We then controlled for two aspects of the sociocultural and physical/built environment, urbanicity (*Model II*) and hospital market (*Model*

III). Models I-III represent state-level estimates. Models IV through VI control for differences within the same initial hospital using hospital fixed effects. Model IV controls for internal hospital factors using hospital fixed effects *(Model IV*). The hospital fixed effect model was stratified by payer (*Model V*) to examine the economic environment, and condition (*Model VI*) to examine the provider environment. Since adjusted odds ratios are difficult to compare between models,[64-66] we report marginal effects[67,68] for significant odds ratios ($p<0.05$) that represent the average differences in the predicted probability of transfer for every patient if we changed races/ethnicity but held all else constant. We also report percent differences using the predicted probability of White or private patients who were transferred to a public hospital as the denominator. Specific details about each model follows.

Model I used hospital-clustered standard errors and year fixed effects, controlling for age, age-squared, sex, comorbidity index, weekend visit, diagnosis at the initial ED visit, severity, initial hospital academic status, and initial hospital bed size. We used age and age-squared because of non-linear relationships. Diagnosis was categorized using AHRQ's Clinical Classification Software (CCS) for ICD-9-CM and Clinical Classification Software Refined (CCS-R) for ICD-10- CM.[69,70]

Sociocultural and Physical/Built Environment. In *Model II*, we added the urbanicity of the initial hospital to Model I. In *Model III*, we replaced urbanicity with hospital referral region (HRR)[71] fixed effects. Prior research used HRRs to measure hospital markets for transferred patients.[47] The HRR fixed effects model examines the within-HRR difference in probability of transfer to a public hospital. Because HRR represents a geographic market, the HRR fixed effects model controls for market-level differences in hospital distribution and local geography, such as the number of public hospitals.

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Internal Hospital Factors. In *Model IV*, we used logistic regression modeling with hospital fixed effects to examine the association between race/ethnicity and payer on the likelihood of transfer to a public hospital for patients within the same initial ED.[72]

Economic Environment. In *Model V*, we stratified Model IV by payer. This model compares patients with the same payer who are within the same hospital, examining if there are racial/ethnic differences in the likelihood of transfer to a public hospital.

Provider Environment. In *Model VI*, we stratified Models IV and V by condition. Specifically, we began by stratifying the sample into patients with an emergency care sensitive condition (ECSCs) (STEMI, moderate/major trauma, stroke, out-of-hospital cardiac arrest, sepsis) or non-ECSC, and then further stratified this "all ECSC conditions" or "all non-ECSC conditions" by payer. Next, we included all payers but stratified on specific conditions. We could not stratify both by payer and specific condition because of sample size. For ECSCs, we further stratified analyses for three conditions based on sample size and transfers that are often protocolized: STEMI, stroke, and moderate/major trauma.[50] At least 95% of HRRs had at least one stroke center, trauma center, and PCI-capable hospital identified as a destination hospital in EMS protocols or the state licensing agency. For non-ECSCs, we selected three conditions that were among the most frequent primary diagnoses of transferred patients: abdominal pain, nonspecific chest pain, and headache, including migraine. For the ECSC/non-ECSC analyses and major trauma, we continued to control for diagnosis using CCS and CCS-R. We did not control for diagnosis for the other specific conditions. The ICD-9/10 and CCS/CCS-R diagnosis codes for these conditions are listed in Appendix II.

Sensitivity Analyses

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We conducted robustness checks. First, Model III controls for HRR but not urbanicity since urbanicity was mostly constant for HRRs. In sensitivity analyses, we control for both. Second, we added potential confounders to Model III in separate models. These were: ownership, distance traveled from the initial hospital to the transferred hospital, Medicare age stratification (under 65 versus 65+), patient household income, and system membership for the initial hospital. Hospitals belonging to hospital systems may preferentially transfer patients within that system,[73,74] changing the probability of transfer to a public hospital if the system does not include a public hospital. Third, to address possible sample bias, we ran two additional models for Models III and IV. In the first, we excluded patients initially presenting to hospitals that are in systems with public hospitals. In the second, we excluded observations where initial hospitals were in HRRs without public hospitals. We did not do this in the main analysis since 19% of transfers were to hospitals outside of the HRR, perhaps because HRR may not fully reflect the ED market.[71] Fourth, we assessed the impact of including transfer disposition codes in Models III and IV.

Results

Descriptive Statistics

We examined 1,265,588 adult ED patients transferred from 187 hospitals. In our sample, 31 (16.6%) hospitals were public, and operated in 10 of 19 HRRs across the state. On average, HRRs with public hospitals were larger and had a higher percentage of transfer patients who were Black or Hispanic, but these differences were not statistically significant. 62.0% of transferred ED patients were White, 13.5% Hispanic, and 21.8% Black. (**Table 1**) 55.0% of the patients were female. 29.4% were enrolled in Medicare, 23.9% were uninsured, 23.6% had

Medicaid, and 19.2% were enrolled in private insurance. Compared to White patients, Black and Hispanic patients were younger, less likely to have a higher triage level, more likely to have Medicaid and less likely to have Medicare, and had fewer comorbidities. These differences were all statistically significant ($p<0.001$).

Among all patients transferred from ED, 13.6% of patients were transferred to public hospitals.

Adjusted Analyses

In this section, we report the percentage point (pp) differences in transfer to a public hospital compared to White or privately-insured patients only if the marginal effects were statistically significant. Odds ratios are in Appendix III.

In the base model (Model 1), which controlled for patient and hospital characteristics, Hispanic and Black patients were 7.0 percentage points (pp) (60.9%) (95% CI: 3.4, 10.5) and 5.1pp (44.3%) (95% CI: 1.9, 8.2) more likely to be transferred to a public hospital compared to White patients. (**Figure 2; Table 2)** Compared to privately-insured patients, uninsured patients were 1.7pp (12.1%) (95% CI: 0.06, 3.3) more likely and Medicare patients were 1.9pp (13.6%) (95% CI: -3.2, -0.5) less likely to be transferred to public hospitals. (**Figure 2; Table 2)**

Sociocultural and Physical/Built Environment. In Model II, (controlling for patient and initial hospital characteristics and hospital urbanicity) Hispanic and Black patients were 9.2pp (81.4%) (95% CI: 5.4, 13.0) and 5.0pp (44.2%) (95% CI: 2.1, 7.9) more likely to be transferred to a public hospital compared to White patients. (**Figure 2; Table 2)** Uninsured patients were 1.7pp (12.3%) (95% CI: 0.3, 3.1) more likely and Medicare patients were 1.5pp (10.9%) (95%

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CI: -2.7, -0.3) less likely to be transferred to a public hospital than privately-insured patients. (**Figure 2; Table 2)**

Model III suggests that compared to White patients within the same HRR, Black patients were 1.9pp (14.1%) (95% CI: 0.06, 3.8) more likely to be transferred to public hospitals. (**Figure 2; Table 2**) Within the same HRR, Hispanic patients had lower odds of transfer to a public hospital, but this was not significant (p=0.056). Uninsured patients were 2.2pp (16.8%) (95% CI: 1.0, 3.5) more likely to be transferred to a public hospital than privately-insured patients within the same HRR. (**Figure 2; Table 2**)

Internal Hospital Factors. Model IV suggests that, compared to White patients within the same initial hospital, Hispanic patients were 0.7pp (5.1%) (95% CI: -0.8, -0.6) less likely and Black patients were 0.8pp (5.9%) (95% CI: 0.6, 0.9) more likely to be transferred to public hospitals compared to White patients within the same initial hospital. (**Table 2**) Compared to privately-insured patients within the same initial hospital, uninsured and Medicaid patients were 1.6pp (12.0%) (95% CI: 1.5, 1.8) and 0.6pp (4.5%) (95% CI: 0.5, 0.8) more likely to be transferred to public hospitals, while Medicare patients were 0.6pp (4.5%) (95% CI: -0.7, -0.4) less likely. (**Table 2**)

Economic Environment. In Model V, we controlled for patient characteristics and hospital fixed effects, but stratified by payer. (**Figure 3**) White patients were most likely to be transferred to public hospitals if they were uninsured (16.3%), and least likely if they had Medicare (12.5%). Compared to White patients from the same initial hospital and with the same payer, Hispanic patients were from 0.6pp to 1.2pp (4.0% to 8.9%) less likely to be transferred to public hospitals, (**Figure 3; Table 2**) and Black patients were from 0.5 to 1.3pp (3.1% to 9.6%) more likely to be transferred to public hospitals. (**Figure 3; Table 2**) The Black-White difference

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between uninsured and Medicaid patients was the least for patients with no insurance and Medicaid (0.5pp for both) (95% CI: 0.3, 0.8) and most for patients with Medicare (1.2pp) (95% CI: 0.9, 1.4) and private insurance (1.3pp) (95% CI: 1.0, 1.6).

Provider Environment. Model VI found differences in the probability of transfer to public hospital by condition. (**Figure 4**) Note that the scales for each figure within Figure 4 differ. Race/ethnic differences in transfer to a public hospital from the same hospital for ECSC conditions were non-significant, except for major trauma (**Figure 4a**) where Hispanic and Black patients had higher probability of transfer to public hospitals compared to White patients. Race/ethnic differences in transfer to public hospitals was generally non-significant for patients with ECSCs with the same payer and from the same initial hospital, except for uninsured patients (**Figure 4b**).

For non-ECSC conditions, Hispanic patients were 0.7pp (5.1%) (95% CI: -0.9, -0.6) less likely, and Black patients were 0.8pp (5.8%) (95% CI: 0.7, 0.9) more likely to be transferred to a public hospital compared to White patients at the same hospital. (**Figure 4c; Table 2**) This relationship generally held true across specific conditions (**Figure 4c**) and when comparing patients with the same payer (**Figure 4d**).

Sensitivity Analyses. The sensitivity analyses results were similar in direction and magnitude to the main analysis (**Appendix IV**), suggesting that the results were robust.

Discussion

Our study suggests that Black non-Hispanic patients were consistently more likely to be transferred to public hospitals compared to White non-Hispanic patients, although the size of the difference varied widely. There was a small Black-White difference in the probability of transfer

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to a public hospital even for patients from the same initial hospital, even when they had the same payer and the same condition. The exception was in models focused on ECSCs, where only Black patients with major trauma were more likely to be transferred to public hospitals compared to White patients. While the non-significance of the STEMI and stroke results may reflect small sample size, these differences may also be less likely to occur for conditions where transfer is highly protocolized.

The large difference in the population-level (base) model — 5.1pp higher probability — was substantially reduced after controlling for hospital market, 1.9pp, and still further reduced after examining differences from the same initial hospital, 0.8pp. Considering the largest reduction in the probability of transfer occurred when controlling for hospital market fixed effects suggests that geography may be particularly important in determining public hospital transfers for Black patients compared to White patients. For instance, social determinants of health at the regional health care market level, including the distribution and availability of hospital services, may play a role. In addition, market differences may reflect important differences in presenting hospital, since we found Black and Hispanic patients are more likely to initially present to larger, more urban and public hospitals than White patients.

Hospital market also played a key role in transfers to public hospital for Hispanic patients compared to White patients. Adding market reduced the magnitude of the difference compared to population-level (base) and adding fixed effects reversed the relationship between ethnicity and public hospital transfer, from 7.0 percentage points in the base model to -0.7 percentage points in the hospital fixed effects model (**Figure 2**). The reversal of the relationship suggests there may be ecological fallacy in the base model. Specifically, Hispanic patients may tend to live in hospital markets where all patients are more likely to be transferred to public hospitals. Thus,

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Hispanic patients may be more likely to be transferred to public hospitals than White patients on a population level, but less likely to be transferred to public hospitals than White patients in the other models.

We may have observed differences in the probability of transfer to public hospitals for several reasons. First, there could be unmeasured confounding. For example, the payer-stratified non-ECSC condition model suggested that the Black-White difference was 1.3pp for Medicare patients from the same hospital; the corresponding E-value[75] suggests that an unmeasured confounder associated with both a patient being Black and being transferred to public hospital with a risk ratio of 1.7 could explain away the association, but the unmeasured confounder must be uncorrelated with hospital, patient severity, weekend/weekday, hour of presentation, diagnosis, comorbidities, age, and sex.

Second, patients of different races/ethnicities might request to be transferred to different hospitals. Approximately 4% of hand surgery patients are transferred because of patient or family request.[76] If this generalizes, a rough estimate suggests our results could be explained if approximately 80.0% more Black patients with non-ECSC conditions requested transfer to a public hospital compared White patients at the same initial hospital. This is so large that it seems improbable to explain the whole difference. Future research could evaluate the extent of patient or family request on transfer destination.

Third, the differences we observe could reflect sample bias. Because our sample consists only of transferred ED patients, it is possible that patients of different races/ethnicities may be non-comparable on unmeasured factors if patients vary in the likelihood of being transferred. There is some support for this. Emergency medical services may initially transport Black patients to different hospitals than they do White patients, even those living within the same zip code;[77-79]

differences in where patients are initially transported might influence the likelihood that a patient is transferred. In addition, previous literature primarily found that Black patients are less likely to be transferred than White patients,[22-24] but that this relationship varies for Hispanic inpatients depending on condition.[21,24,25] This could explain why Hispanic patients with major trauma were more likely to be transferred to a public hospital compared to White patients, but less likely to be transferred for all other conditions examined. Nonetheless, previous literature does not fully answer the question of why there are differences in the likelihood of transfer, nor why it could result in transfer patients with the same payer or condition being transferred to different receiving hospitals.

Fourth, the observed differences might result from implicit bias or discrimination. Providers might determine transfer destination based specifically on race/ethnicity, because race/ethnicity influence their perceptions of patients' clinical states or their assumptions about patients' insurance. For instance, providers may assume that Black patients are uninsured and would prefer to be transferred to public hospitals. There is some evidence that providers make these assumptions. In a "secret shopper" study using simulated patient callers, primary care offices asked more frequently about insurance when a caller self-identified as non-Hispanic Black or Hispanic, compared to White.[80] Our findings that the Black-White difference in transfer to public hospital is smaller when patients with non-ECSCs are uninsured or have Medicaid, compared to when they have Medicare or private insurance, may be consistent with this interpretation.

Regardless of why the differences occur, the fact that there are differences in receiving hospital – particularly for Black versus White patients – is concerning, even if the majority of the difference comes from differences in market and initial hospital. To the extent that disparities in

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transfers to public hospitals may be mediated through the market or hospital in which the patient is initially seen, further investigations of the contextual mechanisms by which such effects may occur are needed. Such multi-level determinants of hospital transfer quality are central to the NET-EQUITY framework. For instance, future studies could examine potential drivers of results, including market-level social determinants of health or hospital-level characteristics.

This study has limitations. First, the study is not causal, and as described above, there may be unmeasured confounders or sample bias. We are also limited to the variables within our dataset and subject to any construct validity issues raised by those variables, including errors in coding of race. Second, our study may have limited generalizability since it is one state. However, Florida is the third most populous state in the United States, making our results still important even if they do not generalize. Third, while our study design relied on the NET-EQUITY model to determine environments that might influence the choice of receiving hospital, there may be ambiguity in the proxies used. For instance, we used condition to proxy for provider environment, as transfer protocols for ECSCs are often institutionalized; but since these conditions may also represent more highly-reimbursed conditions, it may also represent the economic environment. In addition, we only implicitly include the regulatory environment through the use of hospital fixed effects. Future studies could further examine this by examining differences in state laws about transfers.

When EMTALA was enacted, the law's co-sponsor, Senator Edward Kennedy (D-Mass), said "[w]hen one of our citizens arrives at a hospital emergency room with a potentially life-threatening illness or injury, he deserves a checkup and treatment, not a credit check and a trip

down the road."[81] EMTALA only partially addresses the constructive role transfers can play in ensuring that the "trip down the road" takes patients towards, rather than away from, the care they need. The law does not address inequitable access to care, geographic differences in hospital capability[10-14] and capacity,[5-9] differences in racial disparities in EMS transport to hospitals,[77] and hospitals strategically declaring ambulance diversions.[82] This study underscores the necessity to systematically examine all factors that influence the equity of care,[38] and fills in gaps about racial and ethnic differences in ED access to care.

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References

1. Office of Disease Prevention and Health Promotion. Access to Health Services. *Healthy People 2020* 2019; https://www.healthypeople.gov/2020/topics-objectives/topic/Access-to-Health-Services. Accessed December 19, 2019, 2019.
2. Branas CC, MacKenzie EJ, Williams JC, et al. Access to trauma centers in the United States. *Jama*. 2005;293(21):2626-2633.
3. Albright KC, Branas CC, Meyer BC, et al. ACCESS: Acute Cerebrovascular Care in Emergency Stroke Systems. *Archives of Neurology*. 2010;67(10):1210-1218.
4. Carr BG, Bowman AJ, Wolff CS, et al. Disparities in access to trauma care in the United States: A population-based analysis. *Injury*. Feb 2017;48(2):332-338. PMC5292279: PMC5292279
5. Shen YC, Hsia RY, Kuzma K. Understanding the risk factors of trauma center closures: do financial pressure and community characteristics matter? *Medical care*. Sep 2009;47(9):968-978. PMC3121699: PMC3121699
6. Hsia RY, Shen YC. Rising closures of hospital trauma centers disproportionately burden vulnerable populations. *Health affairs (Project Hope)*. Oct 2011;30(10):1912-1920. PMC3287365: PMC3287365
7. Hsia RY, Srebotnjak T, Kanzaria HK, McCulloch C, Auerbach AD. System-level health disparities in California emergency departments: minorities and Medicaid patients are at higher risk of losing their emergency departments. *Ann Emerg Med*. May 2012;59(5):358-365. PMC4636219: PMC4636219
8. Hsia RY, Kellermann AL, Shen YC. Factors associated with closures of emergency departments in the United States. *Jama*. May 18 2011;305(19):1978-1985. PMC4063529: PMC4063529
9. Hsia RY, Asch SM, Weiss RE, et al. California hospitals serving large minority populations were more likely than others to employ ambulance diversion. *Health affairs (Project Hope)*. Aug 2012;31(8):1767-1776. PMC3618957: PMC3618957
10. Hsia RY, Krumholz H, Shen Y-C. Evaluation of STEMI Regionalization on Access, Treatment, and Outcomes Among Adults Living in Nonminority and Minority Communities. *JAMA network open*. 2020;3(11):e2025874-e2025874.
11. Yu CY, Blaine T, Panagos PD, Kansagra AP. Demographic Disparities in Proximity to Certified Stroke Care in the United States. *Stroke*. Jun 10 2021:Strokeaha121034493. PMC8316304: PMC8316304
12. Shen YC, Sarkar N, Hsia RY. Structural Inequities for Historically Underserved Communities in the Adoption of Stroke Certification in the United States. *JAMA Neurol*. Aug 1 2022;79(8):777-786. PMC9237804: PMC9237804
13. Yu CY, Blaine T, Panagos PD, Kansagra AP. Demographic Disparities in Proximity to Certified Stroke Care in the United States. *Stroke*. Aug 2021;52(8):2571-2579. PMC8316304: PMC8316304
14. Hsia R, Shen Y-C. Possible Geographical Barriers to Trauma Center Access for Vulnerable Patients in the United States: An Analysis of Urban and Rural Communities. *Archives of Surgery*. 2011;146(1):46-52. PMC3121679: PMC3121679
15. Kindermann DR, Mutter RL, Cartright-Smith L, Rosenbaum S, Pines JM. Admit or Transfer? The Role of Insurance in High-Transfer-Rate Medical Conditions in the Emergency Department. *Ann Emerg Med*. Dec 13 2014;63(5):561-571.
16. Nacht J, Macht M, Ginde AA. Interhospital transfers from U.S. emergency departments: implications for resource utilization, patient safety, and regionalization. *Academic emergency medicine : official journal of the Society for Academic Emergency Medicine*. Sep 2013;20(9):888-893.
17. Venkatesh AK, Chou SC, Li SX, et al. Association Between Insurance Status and Access to Hospital Care in Emergency Department Disposition. *JAMA internal medicine*. May 1 2019;179(5):686-693. PMC6503571: PMC6503571

Author Manuscript

18. Ward MJ, Kripalani S, Zhu Y, et al. Role of Health Insurance Status in Interfacility Transfers of Patients With ST-Elevation Myocardial Infarction. *The American journal of cardiology.* Aug 1 2016;118(3):332-337. PMC4949088: PMC4949088

19. 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 surgery.* May 2014;149(5):422-430. PMC4422057: PMC4422057

20. Buchmueller TC, Levinson ZM, Levy HG, Wolfe BL. Effect of the Affordable Care Act on Racial and Ethnic Disparities in Health Insurance Coverage. *American journal of public health.* Aug 2016;106(8):1416-1421. PMC4940635: PMC4940635

21. Zachrison KS, Samuels-Kalow ME, Li S, et al. The relationship between stroke system organization and disparities in access to stroke center care in California. *J Am Coll Emerg Physicians Open.* Apr 2022;3(2):e12706. PMC8921441: PMC8921441

22. Tyler PD, Stone DJ, Geisler BP, McLennan S, Celi LA, Rush B. Racial and Geographic Disparities in Interhospital ICU Transfers. *Critical care medicine.* Jan 2018;46(1):e76-e80. PMC5743219: PMC5743219

23. Mueller SK, Zheng J, Orav EJ, Schnipper JL. Rates, Predictors and Variability of Interhospital Transfers: A National Evaluation. *Journal of hospital medicine.* Jun 2017;12(6):435-442.

24. Shannon EM, Zheng J, Orav EJ, Schnipper JL, Mueller SK. Racial/Ethnic Disparities in Interhospital Transfer for Conditions With a Mortality Benefit to Transfer Among Patients With Medicare. *JAMA network open.* Mar 1 2021;4(3):e213474. PMC7998076: PMC7998076

25. Shannon EM, Schnipper JL, Mueller SK. Identifying Racial/Ethnic Disparities in Interhospital Transfer: an Observational Study. *Journal of general internal medicine.* 2020;35(10):2939-2946.

26. Gourevitch MN, Malaspina D, Weitzman M, Goldfrank LR. The public hospital in American medical education. *J Urban Health.* Sep 2008;85(5):779-786. PMC2527439: PMC2527439

27. Werner RM, Goldman LE, Dudley RA. Comparison of change in quality of care between safety-net and non-safety-net hospitals. *Jama.* May 14 2008;299(18):2180-2187.

28. Mouch CA, Regenbogen SE, Revels SL, Wong SL, Lemak CH, Morris AM. The quality of surgical care in safety net hospitals: a systematic review. *Surgery.* May 2014;155(5):826-838.

29. Sarkar RR, Courtney PT, Bachand K, et al. Quality of care at safety-net hospitals and the impact on pay-for-performance reimbursement. *Cancer.* Oct 15 2020;126(20):4584-4592.

30. Talutis SD, Chen Q, Wang N, Rosen AK. Comparison of Risk-Standardized Readmission Rates of Surgical Patients at Safety-Net and Non-Safety-Net Hospitals Using Agency for Healthcare Research and Quality and American Hospital Association Data. *JAMA surgery.* May 1 2019;154(5):391-400. PMC6537916: PMC6537916

31. McHugh M, Kang R, Hasnain-Wynia R. Understanding the Safety Net Inpatient Quality of Care Varies Based on How One Defines Safety-Net Hospitals. *Medical Care Research and Review.* Oct 2009;66(5):590-605.

32. Hsia RY, Sarkar N, Shen YC. Impact Of Ambulance Diversion: Black Patients With Acute Myocardial Infarction Had Higher Mortality Than Whites. *Health affairs (Project Hope).* Jun 01 2017;36(6):1070-1077.

33. Jo S, Jeong T, Jin YH, Lee JB, Yoon J, Park B. ED crowding is associated with inpatient mortality among critically ill patients admitted via the ED: post hoc analysis from a retrospective study. *The American journal of emergency medicine.* Dec 2015;33(12):1725-1731.

34. Jo S, Jin YH, Lee JB, Jeong T, Yoon J, Park B. Emergency department occupancy ratio is associated with increased early mortality. *The Journal of emergency medicine.* Feb 2014;46(2):241-249.

35. Johnson KD, Winkelman C. The effect of emergency department crowding on patient outcomes: a literature review. *Advanced emergency nursing journal.* Jan-Mar 2011;33(1):39-54.

36. Sun BC, Hsia RY, Weiss RE, et al. Effect of Emergency Department Crowding on Outcomes of Admitted Patients. *Annals of Emergency Medicine.* Jun 2013;61(6):605-611.

Author Manuscript

37. Hsuan C, Segel JE, Hsia RY, Wang Y, Rogowski J. Association of emergency department crowding with inpatient outcomes. *Health services research.* Sep 26 2022.

38. Hsuan C, Carr BG, Vanness D, et al. A Conceptual Framework for Optimizing the Equity of Hospital-Based Emergency Care: The Structure of Hospital Transfer Networks. *Milbank Q.* Mar 2023;101(1):74-125. PMC10037699: PMC10037699

39. Kindermann DR, Mutter RL, Houchens RL, Barrett ML, Pines JM. Emergency department transfers and transfer relationships in United States hospitals. *Academic emergency medicine : official journal of the Society for Academic Emergency Medicine.* Feb 2015;22(2):157-165.

40. Martinez R, Carr B. Creating Integrated Networks Of Emergency Care: From Vision To Value. *Health Affairs.* 2013;32(12):2082-2090.

41. MacKinney AC, Mueller KJ, Coburn AF, Knudson A, Lundblad JP, McBride TD. *Characteristics and Challenges of Rural Ambulance Agencies – A Brief Review and Policy Considerations* Rural Policy Research Institute;2021.

42. Medford-Davis LN, Phelps M, Hausknecht P, Meisel ZF, Reitman C, Fisher AS. Indirect referral of orthopaedic patients to a safety-net hospital. *Journal of health care for the poor and underserved.* 2016;27(3):1267-1277.

43. Hsia RY, MacIsaac D, Baker LC. Decreasing reimbursements for outpatient emergency department visits across payer groups from 1996 to 2004. *Ann Emerg Med.* Mar 2008;51(3):265-274, 274.e261-265.

44. Hsuan C, Horwitz JR, Ponce NA, Hsia RY, Needleman J. Complying with the Emergency Medical Treatment and Labor Act (EMTALA): Challenges and solutions. *Journal of healthcare risk management : the journal of the American Society for Healthcare Risk Management.* Jan 2018;37(3):31-41. PMC8340543: PMC8340543

45. Veinot TC, Bosk EA, Unnikrishnan KP, Iwashyna TJ. Revenue, relationships and routines: The social organization of acute myocardial infarction patient transfers in the United States. *Social Science & Medicine.* 2012/11/01/ 2012;75(10):1800-1810. PMC3626995: PMC3626995

46. Lu LX, Lu SF. Distance, Quality, or Relationship? Interhospital Transfer of Heart Attack Patients. *Production and Operations Management.* 2018;27(12):2251-2269.

47. Zachrison KS, Dhand A, Schwamm LH, Onnela JP. A Network Approach to Stroke Systems of Care. *Circ Cardiovasc Qual Outcomes.* Aug 2019;12(8):e005526. PMC6822608: PMC6822608

48. Miami-Dade Fire Rescue. Miami-Dade Fire Rescue Medical Operations Manual, Protocol 4: Patient Treatment and Transport. 2022; https://mdsceh.miamidade.gov/mobi/moms/protocol%2004.pdf. Accessed December 16, 2022.

49. Broward Sherrif's Office Department of Fire Rescue and Emergency Services. EMS Protocols 2022.v2. 2022; https://browardcountyems.org/wp-content/uploads/2022/05/BSOProtocol2022.v2_FINAL.pdf. Accessed December 16, 2022.

50. Carr BG, Conway PH, Meisel ZF, Steiner CA, Clancy C. Defining the emergency care sensitive condition: a health policy research agenda in emergency medicine. *Ann Emerg Med.* Jul 2010;56(1):49-51.

51. Heppner Z, Shreffler J, Polites A, Ross A, Thomas JJ, Huecker M. COVID-19 and emergency department volume: The patients return but have different characteristics. *The American journal of emergency medicine.* Jul 2021;45:385-388. PMC7481071: PMC7481071

52. Harlan EA, Mubarak E, Firn J, Goold SD, Shuman AG. Inter-hospital Transfer Decision-making During the COVID-19 Pandemic: a Qualitative Study. *Journal of general internal medicine.* May 30 2023:1-9. PMC10228431: PMC10228431

53. Butt AA, Azad AM, Kartha AB, Masoodi NA, Bertollini R, Abou-Samra AB. Volume and Acuity of Emergency Department Visits Prior To and After COVID-19. *The Journal of emergency medicine.* Nov 2020;59(5):730-734. PMC7413056: PMC7413056

54. 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.* Sep 2010;3(5):468-475. PMC3103265: PMC3103265

Author Manuscript

55. Zachrison KS, Onnela JP, Reeves MJ, et al. Hospital Factors Associated With Interhospital Transfer Destination for Stroke in the Northeast United States. *Journal of the American Heart Association.* Jan 7 2020;9(1):e011575. PMC6988147: PMC6988147

56. Mueller SK, Zheng J, Orav J, Schnipper JL. Interhospital Transfer and Receipt of Specialty Procedures. *Journal of hospital medicine.* Jun 1 2018;13(6):383-387. PMC5940580: PMC5940580

57. Kindermann D, Mutter R, Pines J. *Emergency Department Transfers to Acute Care Facilities, 2009: Statistical Brief #155.* Rockville (MD): Agency for Healthcare Research and Quality (US) ;2013.

58. Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. *Journal of chronic diseases.* 1987;40(5):373-383.

59. Quan H, Sundararajan V, Halfon P, et al. Coding algorithms for defining comorbidities in ICD-9-CM and ICD-10 administrative data. *Medical care.* Nov 2005;43(11):1130-1139.

60. *CHARLSON: Stata module to calculate Charlson index of comorbidity* [computer program]. Boston College Department of Economics: Statistical Software Components S456719; 2017.

61. Hahn B, Zuckerman B, Durakovic M, Demissie S. The relationship between emergency department volume and patient complexity. *The American journal of emergency medicine.* Mar 2018;36(3):366-369.

62. CGS Administrators, Center for Medicare and Medicaid Services. CPT Code 99285 Fact Sheet. 2019; https://www.cgsmedicare.com/partb/mr/pdf/99285.pdf. Accessed October 25, 2023, 2023.

63. Ingram D, Franco S. 2013 NCHS Urban-Rural Classification Scheme for Counties. In: Services DoHaH, ed. Vol 2. Hyattsville, MD2014.

64. Norton EC, Dowd BE, Maciejewski ML. Odds Ratios-Current Best Practice and Use. *Jama.* Jul 3 2018;320(1):84-85.

65. Norton EC, Dowd BE, Maciejewski ML. Marginal Effects-Quantifying the Effect of Changes in Risk Factors in Logistic Regression Models. *Jama.* Apr 2 2019;321(13):1304-1305.

66. Norton EC, Dowd BE. Log Odds and the Interpretation of Logit Models. *Health services research.* Apr 2018;53(2):859-878. PMC5867187: PMC5867187

67. Williams R. Using the margins command to estimate and interpret adjusted predictions and marginal effects. *Stata Journal.* 2012;12(2):308-331.

68. Jann B. Plotting regression coefficients and other estimates. *The Stata Journal.* 2014;14(4):708-737.

69. Healthcare Cost and Utilization Project (HCUP). Clinical Classification Software (CCS) for ICD-9-CM. 2017; www.hcup-us.ahrq.gov/toolssoftware/ccs/ccs.jsp. Accessed November 21, 2022, 2022.

70. Healthcare Cost and Utilization Project (HCUP). Clinical Classifications Software Refined (CCSR) for ICD-10-CM Diagnoses. 2022; https://www.hcup-us.ahrq.gov/toolssoftware/ccsr/dxccsr.jsp#:~:text=Internet%20Citation%3A%20Clinical%20Classifications%20Software,and%20Quality%2C%20Rockville%2C%20MD. Accessed November 21, 2022, 2022.

71. Kilaru AS, Wiebe DJ, Karp DN, Love J, Kallan MJ, Carr BG. Do hospital service areas and hospital referral regions define discrete health care populations? *Medical care.* Jun 2015;53(6):510-516.

72. Rabe-Hesketh S, Skrondal A. *Multilevel and Longitudinal Modeling Using STATA.* 2 ed. College Station, TX: STATA Press; 2008.

73. Ifejika NL, Wiegand J, Harbold H, et al. The "Network Effect" on Interfacility Transfers Among Regional Stroke Certified Hospitals. *J Stroke Cerebrovasc Dis.* Aug 24 2021;30(11):106056.

74. Lu LX, Lu SF. Distance, Quality, or Relationship? Interhospital Transfer of Heart Attack Patients. *Production and Operations Management.* 2018;27(12):2251-2269.

Author Manuscript

75. VanderWeele TJ, Ding P. Sensitivity Analysis in Observational Research: Introducing the E-Value. *Annals of internal medicine.* Aug 15 2017;167(4):268-274.

76. Kummerow Broman K, Phillips S, Hayes RM, et al. Insurance status influences emergent designation in surgical transfers. *The Journal of surgical research.* Feb 2016;200(2):579-585. PMC4691367: PMC4691367

77. Hanchate AD, Paasche-Orlow MK, Baker WE, Lin MY, Banerjee S, Feldman J. Association of Race/Ethnicity With Emergency Department Destination of Emergency Medical Services Transport. *JAMA network open.* Sep 4 2019;2(9):e1910816. PMC6735492 PMC6735492

78. Pack CE, Partain AT, Crowe RP, Brown LH. Ambulance Transport Destinations In The US Differ By Patient Race And Ethnicity. *Health affairs (Project Hope).* Feb 2023;42(2):237-245.

79. Hanchate AD, Baker WE, Paasche-Orlow MK, Feldman J. Ambulance diversion and ED destination by race/ethnicity: evaluation of Massachusetts' ambulance diversion ban. *BMC health services research.* Aug 3 2022;22(1):987. PMC9347077: PMC9347077

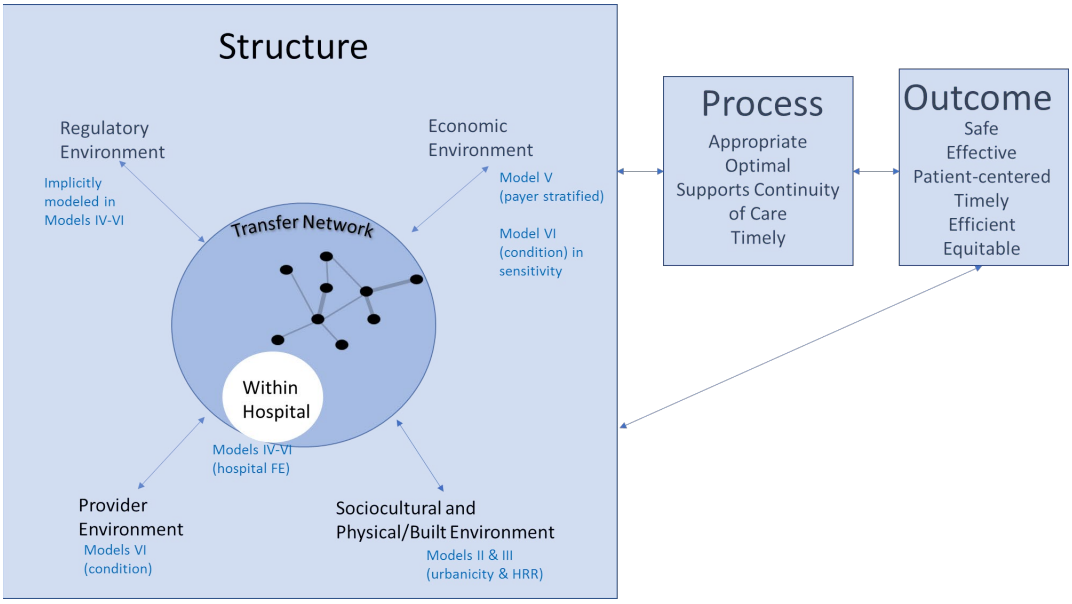
80. Wisniewski JM, Walker B. Association of Simulated Patient Race/Ethnicity With Scheduling of Primary Care Appointments. *JAMA network open.* 2020;3(1):e1920010-e1920010.

81. Rich S. Emergency Room Access May Widen: Congress Would Forbid Hospitals to 'Dump' the Poor, Uninsured. *Washington Post.* March 29, 1986, 1986.

82. Hsuan C, Hsia R, Horwitz J, Ponce N, Rice T, J N. Ambulance Diversions Following Public Hospital Emergency Department Closures. *Health services research.* 2019;54(4):870-879. PMC6606538: PMC6606538

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Figure 1. Application of NET-EQUITY to the Study



Note: this is a revised version of the NET-EQUITY model, which was published in Hsuan (2023)[38] © 2023 The Milbank Memorial Fund.

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Table 1: Descriptive Statistics of Sample, by Race/Ethnicity

	All	White non-Hispanic	Hispanic	Black non-Hispanic	Other/missing
N	1,265,588	784,324	171,049	275,780	34,435
Transfer to Public Hospital	13.6%	11.6%	18.7%	16.3%	11.6%
Visit Characteristics					
Female***	55.0%	52.5%	56.9%	60.9%	54.7%
Mean Age***	46.8	49.7	44.9	39.9	44.7
Primary Payer***					
Private	19.2%	19.6%	20.5%	16.7%	22.4%
Medicare	29.4%	33.8%	25.0%	20.3%	22.7%
Uninsured	23.9%	23.2%	22.8%	25.7%	30.1%
Medicaid	23.6%	19.2%	29.2%	33.4%	19.1%
Other	4.0%	4.2%	2.7%	3.9%	5.7%
Weekend***	27.2%	27.7%	26.5%	26.5%	26.4%
Highest Severity[a],***	62.6%	66.1%	59.2%	55.6%	55.8%
Charlson Comorbidity Index***					
0	86.4%	85.3%	88.3%	88.0%	59.6%
1	8.9%	10.00%	7.9%	6.9%	6.8%
2	4.6%	4.7%	3.9%	5.1%	3.6%
Hospital Characteristics					
Teaching***	49.0%	41.6%	57.2%	61.7%	60.3%
Size[b],***					
Large	22.3%	17.1%	27.2%	32.0%	29.3%
Medium	21.9%	19.5%	22.5%	27.9%	23.2%
Small-medium	37.6%	41.6%	38.2%	27.5%	33.0%
Small	18.1%	21.9%	12.0%	12.7%	14.5%
Urbanicity***					
Large Central Metropolitan Area	30.3%	22.5%	50.8%	37.4%	35.3%
Large Fringe Metropolitan Area	26.8%	25.9%	27.8%	28.4%	28.3%
Medium Metropolitan Area	24.6%	27.8%	14.3%	22.8%	21.3%
Small metro, micropolitan, non-core	18.3%	23.8%	7.1%	11.4%	15.1%
Ownership***					
Public	15.3%	13.5%	18.2%	18.8%	10.4%

Nonprofit	43.9%	44.1%	44.1%	42.9%	47.5%
For Profit	40.8%	42.4%	37.7%	38.4%	42.1%

*p<0.05, **p<0.01, ***p<0.001

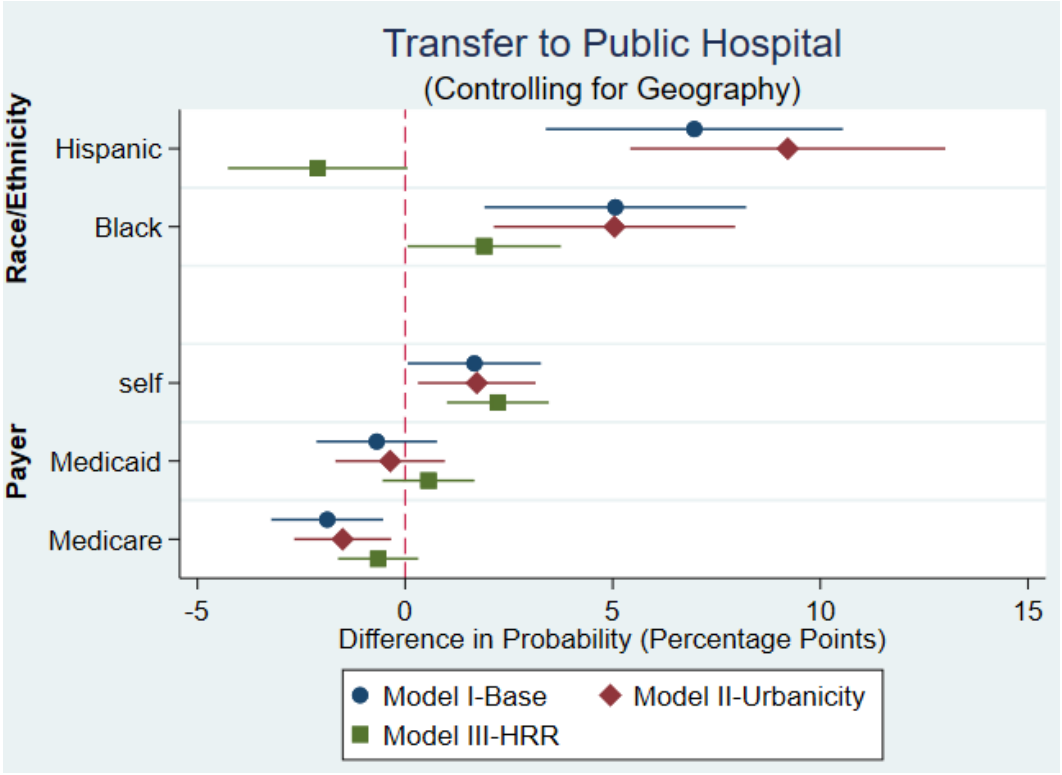
[a]Highest severity is based on Current Procedural Terminology (CPT) codes, and coded as yes if the CPT codes are: 99284, 99285, 99291, 99292, G0383, or G0384.

[b]Hospital size is classified as large (500+), medium (300-499), small-medium (100-299 beds), and small (0-99 beds)

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Figure 2. Difference in Predicted Probability of Transfer to Public Hospital, Base Model and Controlling for Geography



Notes. Describes the difference in probability of transfer to public hospitals in percentage points (ie marginal effects representing the average differences in the predicted probability of transfer for every patient if we changed races/ethnicity but held all else constant (in percentage points)). All models are logistic regression models with clustered standard errors and year fixed effects. Model I controls for severity (Current Procedural Terminology (CPT®) code), Charlson comorbidity index, weekend visit, age, age squared, diagnosis, academic hospital, and hospital size. Model II controls for all covariates in Model I and additionally controls for urbanicity. Model III controls for all covariates in Model I and contains fixed effects for hospital referral region. Error bars represent 95% confidence intervals. Other/missing race/ethnicity and other/missing payer were omitted from figure for clarity, but were included in regression models.

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Table 2. Difference in Predicted Probability of Transfer to Public Hospital, by Model

a. Models I-V

	Model I	Model II	Model III	Model IV	Model V			
					Uninsured	Medicaid	Medicare	Private
Predicted Probability (95% CI)								
White	11.5% (8.4%, 14.5%)	11.3% (8.5%, 14.1%)	13.5% (10.9%, 16.2%)	13.6% (13.5%, 13.7%)	16.3% (16.2%, 16.5%)	14.5% (14.3%, 14.6%)	12.5% (12.3%, 12.6%)	14.3% (14.1%, 14.5%)
Private	14.0% (10.5%, 17.6%)	13.8% (10.7%, 17.0%)	13.1% (10.8%, 15.4%)	13.3% (13.1%, 13.4%)				
Difference in Predicted Probability (95% CI)								
Race								
White	[ref]	[ref]	[ref]	[ref]	[ref]	[ref]	[ref]	[ref]
Hispanic	7.0 (3.4, 10.5)***	9.2 (5.4, 13.0)***	-2.1 (-4.3, 0.5)	-0.7 (-0.8, -0.6)***	-0.1 (-0.5, 0.2)	-1.2 (-1.5, -0.9)***	-0.8 (-1.0, -0.5)***	-0.6 (-0.9, -0.3)***
Black	5.1 (1.9, 8.2)**	5.0 (2.1, 7.9)**	1.9 (.06, 3.8)*	0.8 (0.6, 0.9)***	0.5 (0.3, 0.8)***	0.5 (0.3, 0.8)***	1.2 (0.9, 1.4)***	1.3 (1.0, 1.6)***
Payer								
Private	[ref]	[ref]	[ref]	[ref]				
Uninsured	1.7 (0.6, 3.3)*	1.7 (0.3, 3.1)*	2.2 (1.0, 3.5)***	1.6 (1.5, 1.8)***				
Medicaid	-0.7 (-2.1, 0.8)	-0.4 (-1.7, 1.0)	0.6 (-0.5, 1.7)	0.6 (0.5, 0.8)***				
Medicare	-1.9 (-3.2, -0.5)**	-1.5 (-2.7, -0.3)*	-0.6 (-1.6, 0.3)	-0.6 (-0.7, -0.4)***				
Controlling for								
Patient characteristics	X	X	X	X	X	X	X	X
Hospital characteristics	X	X	X					
Urbanicity		X						
HRR			X					
Hospital FE				X	X	X	X	X
Stratified by								
Payer					X	X	X	X
Condition								

***p<0.001, **p<0.01, *p<0.05

b. Model VI

	ECSC				Non-ECSC			
	All ECSCs	STEMI	Major Trauma	Stroke	All Non-ECSCs	Abdominal Pain	Chest Pain	Headache
Predicted Probability								

White	20.5% (20.1%, 20.8%)	42.3% (41.8%, 44.0%)	9.1% (8.7%, 9.5%)	25.3% (24.1%, 26.6%)	13.7% (13.6%, 13.8%)	15.2% (14.9%, 15.5%)	17.3% (16.9%, 17.8%)	17.6% (16.9%, 18.3%)
Private	21.1% (20.4%, 21.8%)	42.5% (40.6%, 44.3%)	12.9% (11.8%, 13.9%)	25.4% (23.0%, 27.8%)	13.3% (13.2%, 13.4%)	14.6% (14.1%, 15.0%)	17.0% (16.4%, 17.7%)	17.3% (16.5%, 18.1%)
Difference in Predicted Probability								
Race								
White	[ref]	[ref]	[ref]	[ref]	[ref]	[ref]	[ref]	[ref]
Hispanic	0.7 (-0.4, 1.7)	0.6 (-2.0, 3.3)	10.4 (8.8, 12.0)***	1.2 (-2.2, 4.7)	-0.7 (-0.9, -0.6)***	-1.3 (-1.9, -0.7)***	-0.9 (1.8, 0.03)	-0.5 (-1.7, 0.8)
Black	-0.04 (-1.0, 1.0)	-1.1 (-3.9, 1.6)	6.1 (4.4, 7.8)***	-1.7 (-4.6, 1.2)	0.8 (0.7, 0.9)***	1.6 (1.0, 2.1)***	1.4 (0.6, 2.2)***	2.2 (1.1, 3.3)***
Payer								
Private	[ref]	[ref]	[ref]	[ref]	[ref]	[ref]	[ref]	[ref]
Uninsured	-0.5 (-1.5, 0.6)	1.2 (-1.4, 3.8)	-1.4 (-2.9, 0.03)	-0.02 (3.6, 3.5)	1.7 (1.6, 1.9)***	1.8 (1.2, 2.4)***	1.9 (1.0, 2.8)***	2.8 (1.6, 4.0)***
Medicaid	-1.6 (2.8, -0.3)*	0.5 (-2.8, 3.7)	-2.9 (-4.6, -1.1)**	-0.6 (4.4, 3.2)	0.7 (0.5, 0.8)***	0.9 (0.4, 1.6)**	0.9 (-0.04, 1.7)	1.1 (-0.04, 2.3)
Medicare	-0.7 (-1.6, 0.3)	0.4 (-2.3, 3.0)	-2.9 (-4.2, -1.6)***	0.1 (-2.9, 3.2)	-0.6 (-0.8, -0.4)***	-0.4 (-1.1, 0.4)	-0.7 (-1.6, 0.3)	-1.1 (-2.5, 0.3)
Controlling for								
Patient characteristics	X	X	X	X	X	X	X	X
Hospital characteristics								
Urbanicity								
HRR								
Hospital FE	X	X	X	X	X	X	X	X
Stratified by								
Payer								
Condition	X	X	X	X	X	X	X	X

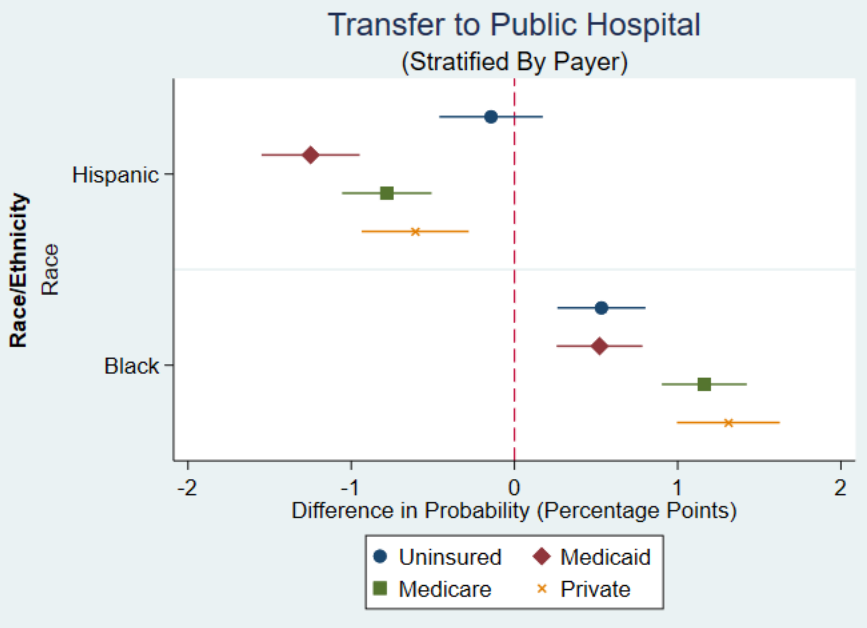
Abbreviations. ECSCs = emergency care sensitive condition; FE = fixed effects; HRR = hospital referral region; STEMI = ST-elevation myocardial infarction

Notes: In percentage points. Numbers reflect marginal effects representing the average differences in the predicted probability of transfer for every patient if we changed races/ethnicity but held all else constant (in percentage points), generated from logistic regression models. Bold indicates that the coefficient is statistically significant ($p<0.05$) in the logistic regression model. Model I is a logistic regression with clustered SEs and year fixed effects, controlling for severity, Charlson comorbidity index, weekend visit, age, age squared, diagnosis, academic hospital, and hospital size. Model II additionally controls for urbanicity. Model III contains fixed effects for hospital referral region. Model IV is a logistic regression with year and hospital fixed effects, controlling for severity, Charlson comorbidity index, weekend visit, age, age squared, and diagnosis. Model V is Model IV but stratified by payer. Model VI is Model IV but stratified by condition. Other/missing race/ethnicity and other/missing payer were omitted from figure for clarity, but were included in regression models.

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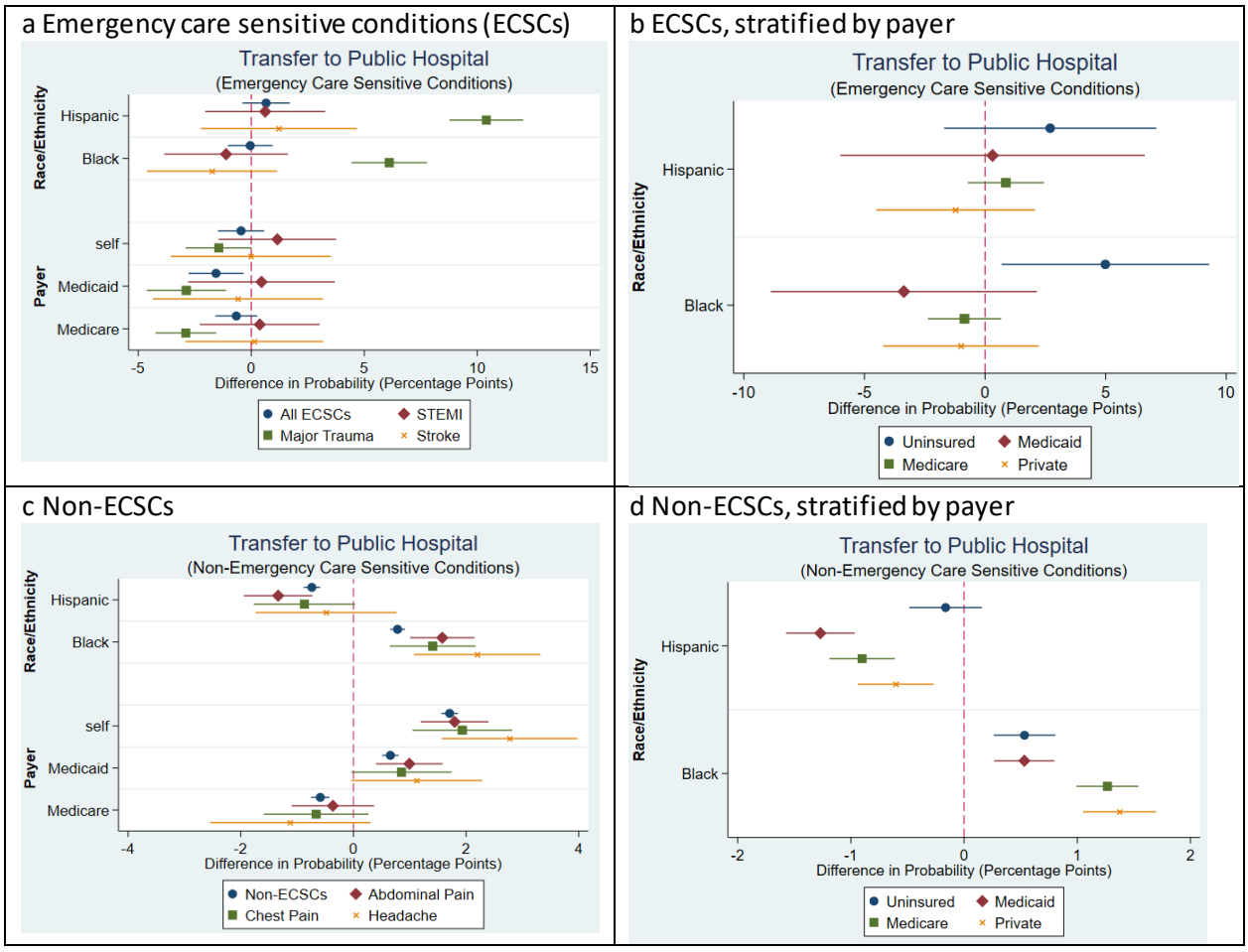
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Figure 3. Difference in Predicted Probability of Transfer to Public Hospital, Stratified by Payer



Notes. In percentage points. Numbers represent marginal effects representing the average differences in the predicted probability of transfer for every patient if we changed races/ethnicity but held all else constant (in percentage points), generated from Model V, which are four logistic regression models stratified by payer. All models are logistic regression models with hospital fixed effects, controlling for severity (Current Procedural Terminology (CPT®) code), Charlson comorbidity index, weekend visit, age, age squared, diagnosis, and year. Error bars represent 95% confidence intervals. Other/missing race/ethnicity and other/missing payer were omitted from figure for clarity, but were included in regression models.

Figure 4. Probability of transfer to public hospital, by condition (hospital fixed effects)

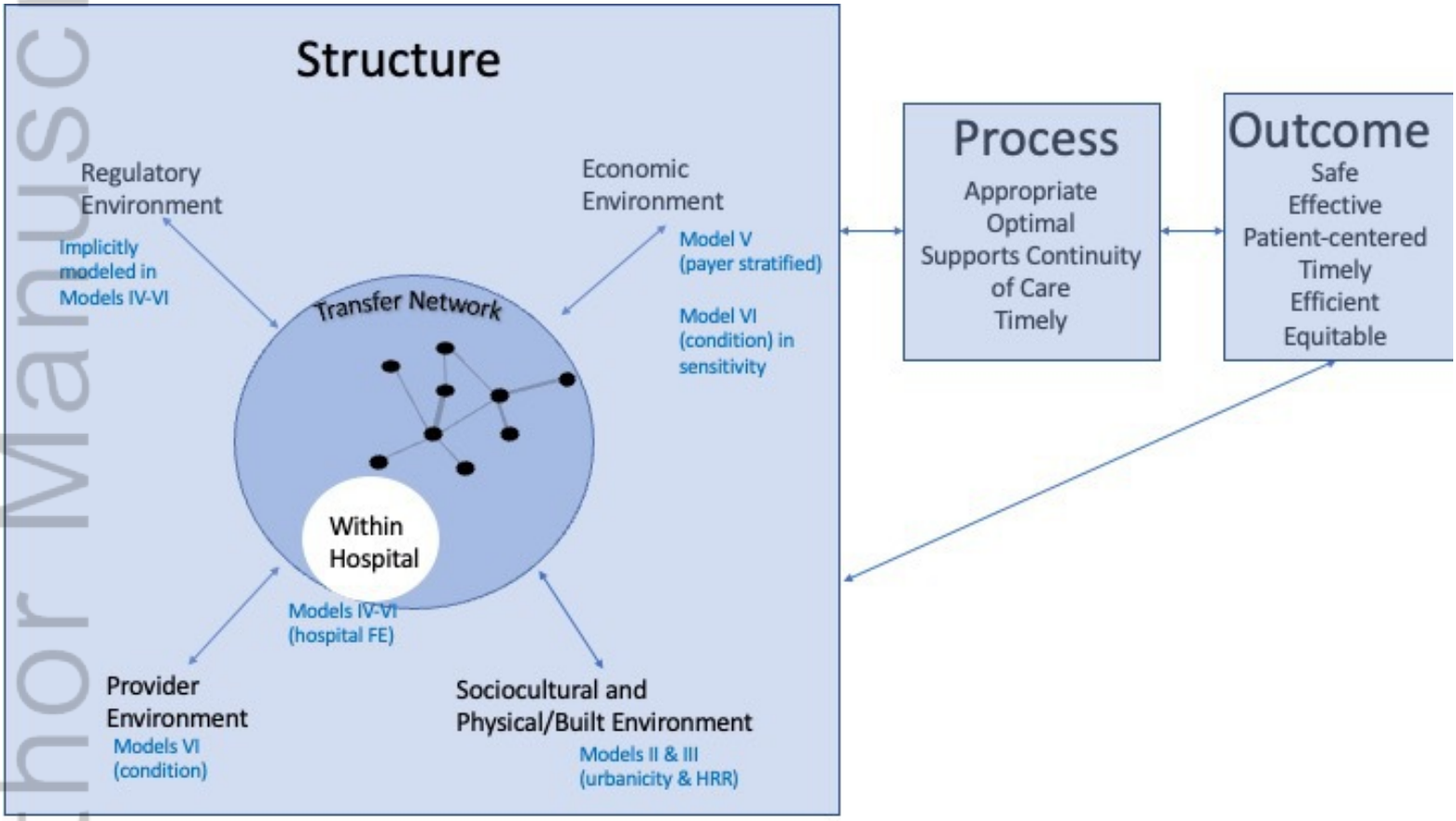


Abbreviations. ECSCs = emergency care sensitive condition

Notes. Note that the scales on the X-axis are different. Difference in probability reflects marginal effects representing the average differences in the predicted probability of transfer for every patient if we changed races/ethnicity but held all else constant (in percentage points), generated from Model VI, which are logistic regression models stratified by condition. All models are logistic regression models with hospital fixed effects, controlling for severity (Current Procedural Terminology (CPT®) code), Charlson comorbidity index, weekend visit, age, age squared, and year. Condition was additionally controlled for in the overall ECSC, non-ECSC, and trauma models. The non-payer stratified models controlled for payer. Error bars represent 95% confidence intervals. Other/missing race/ethnicity and other/missing payer were omitted from figure for clarity, but were included in regression models.

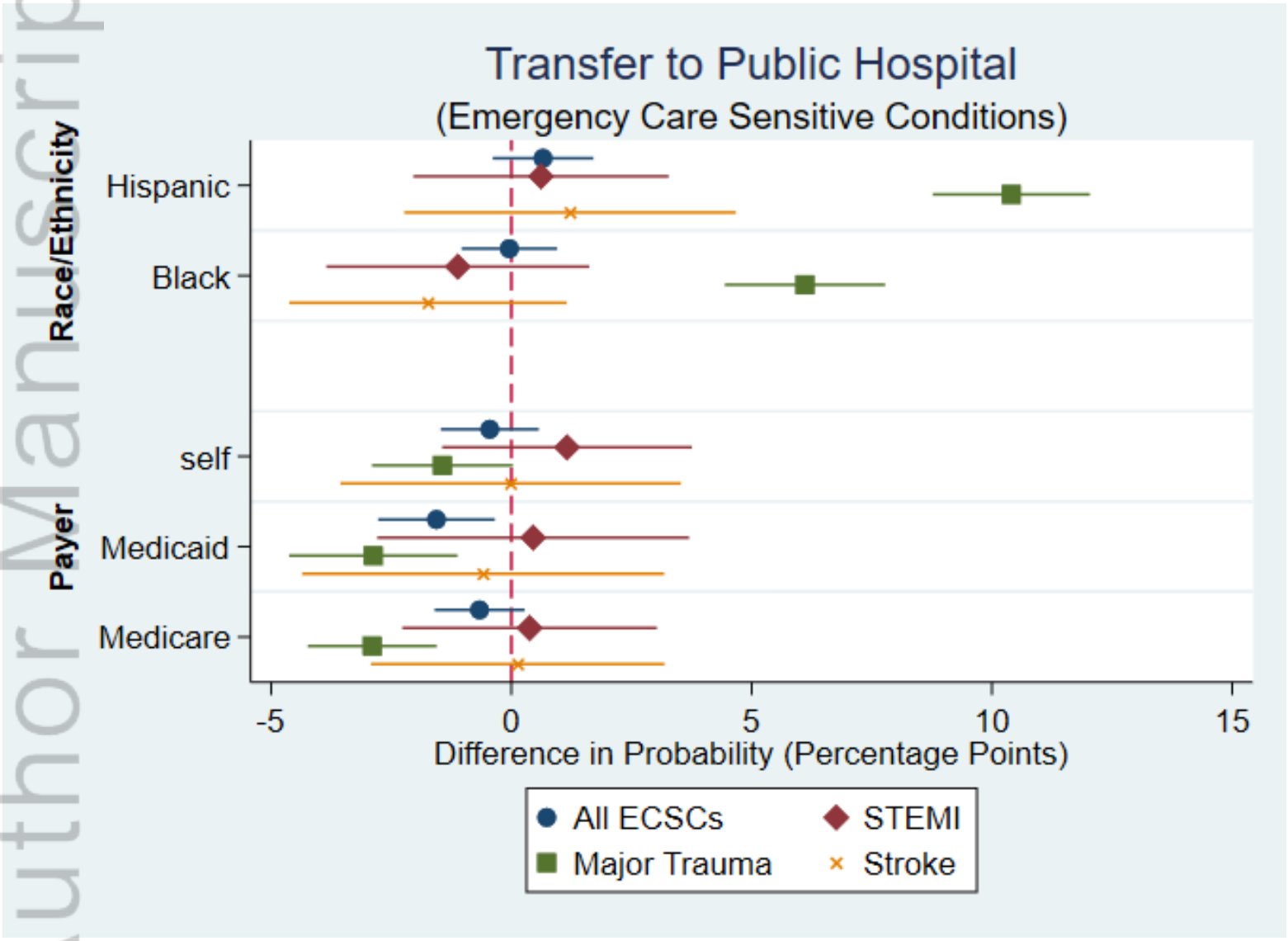
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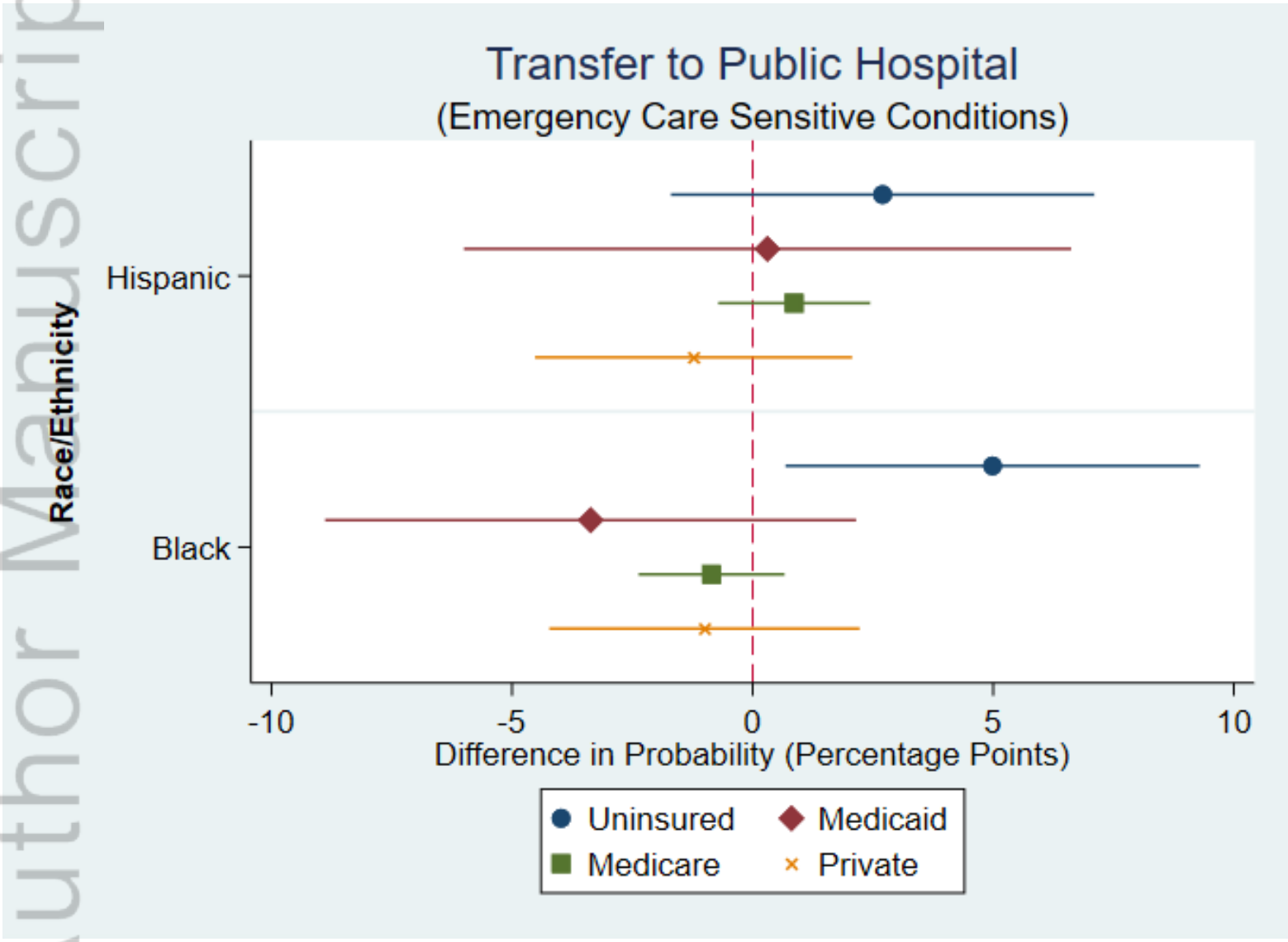
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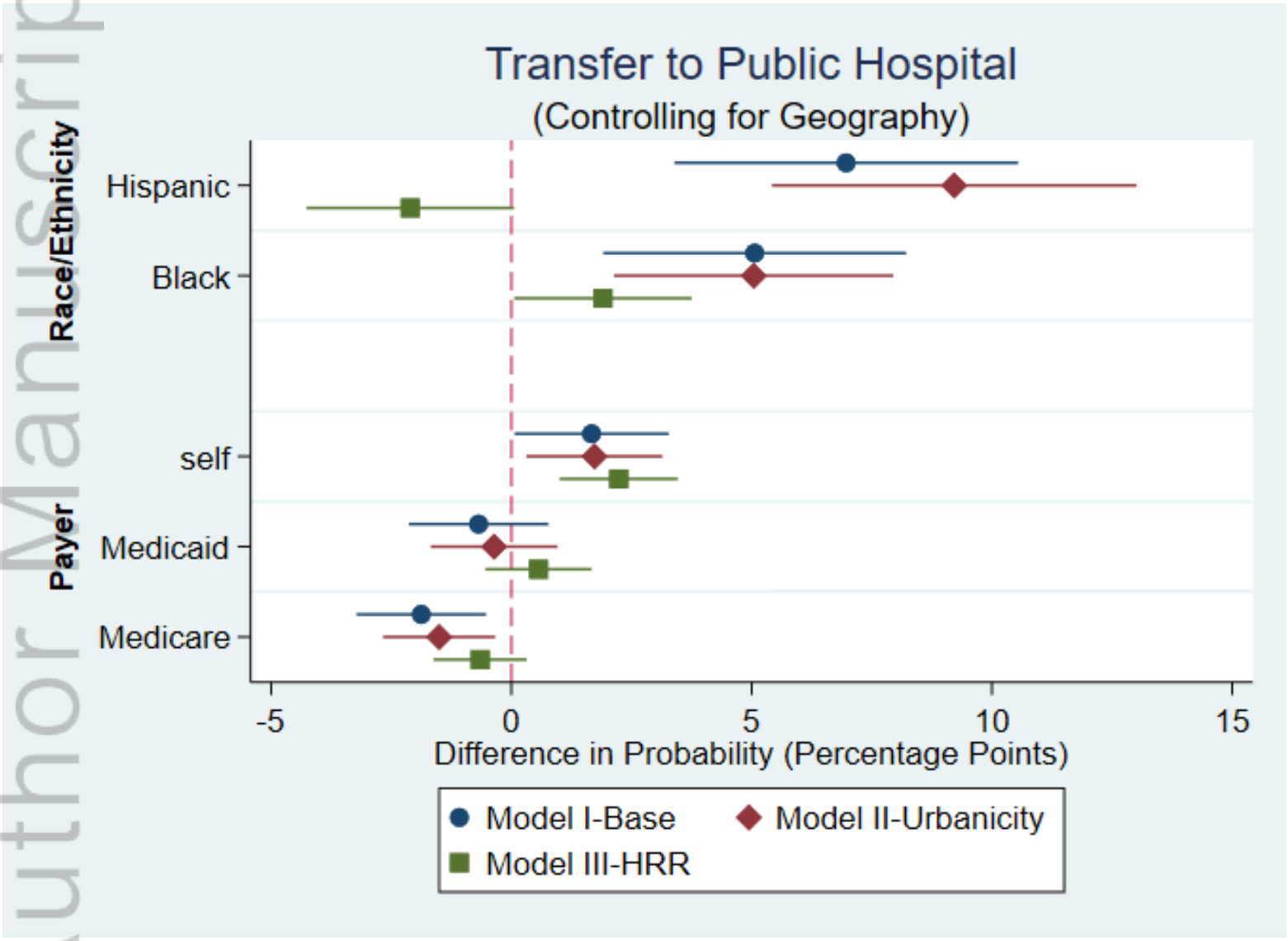
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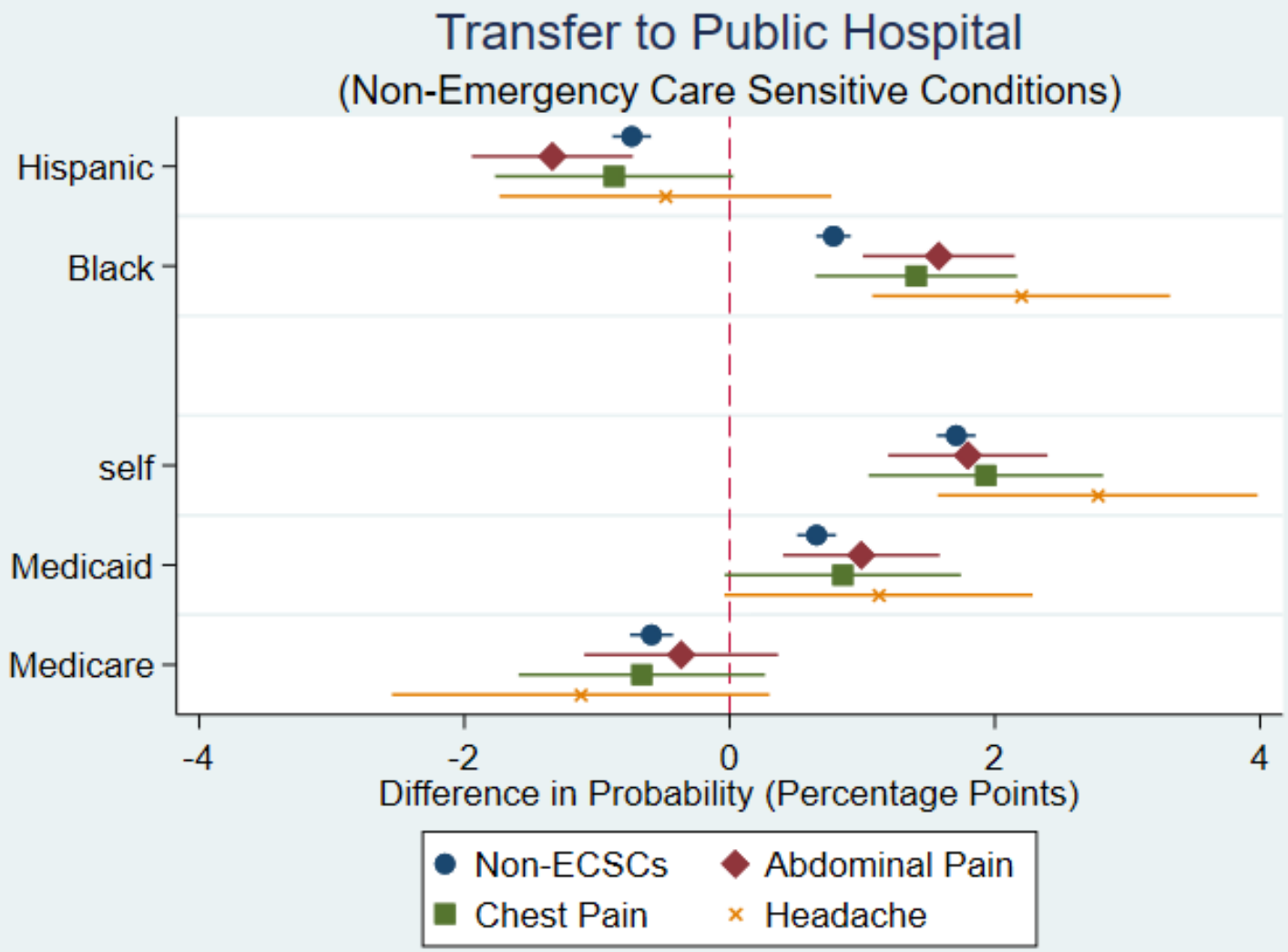
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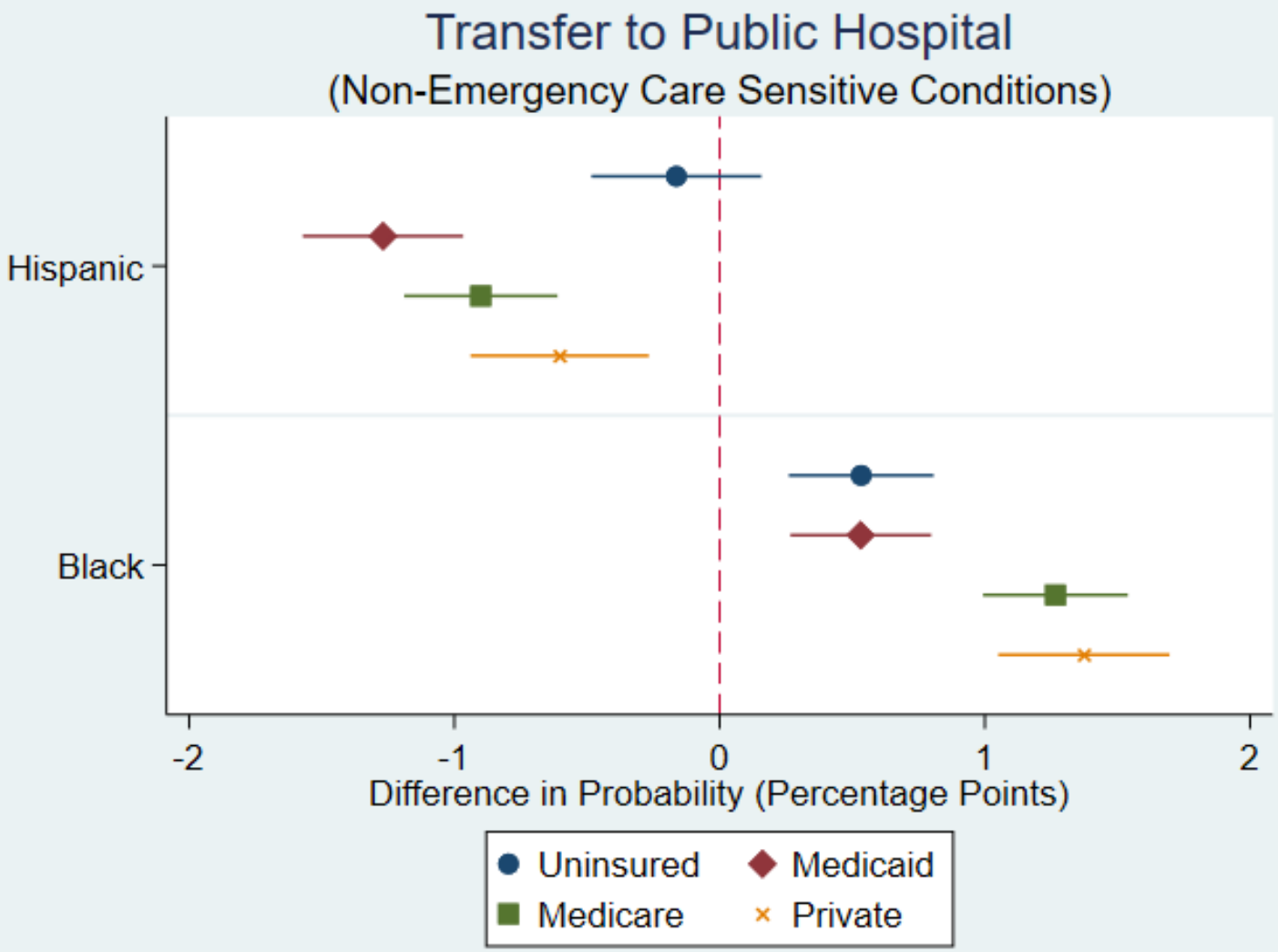
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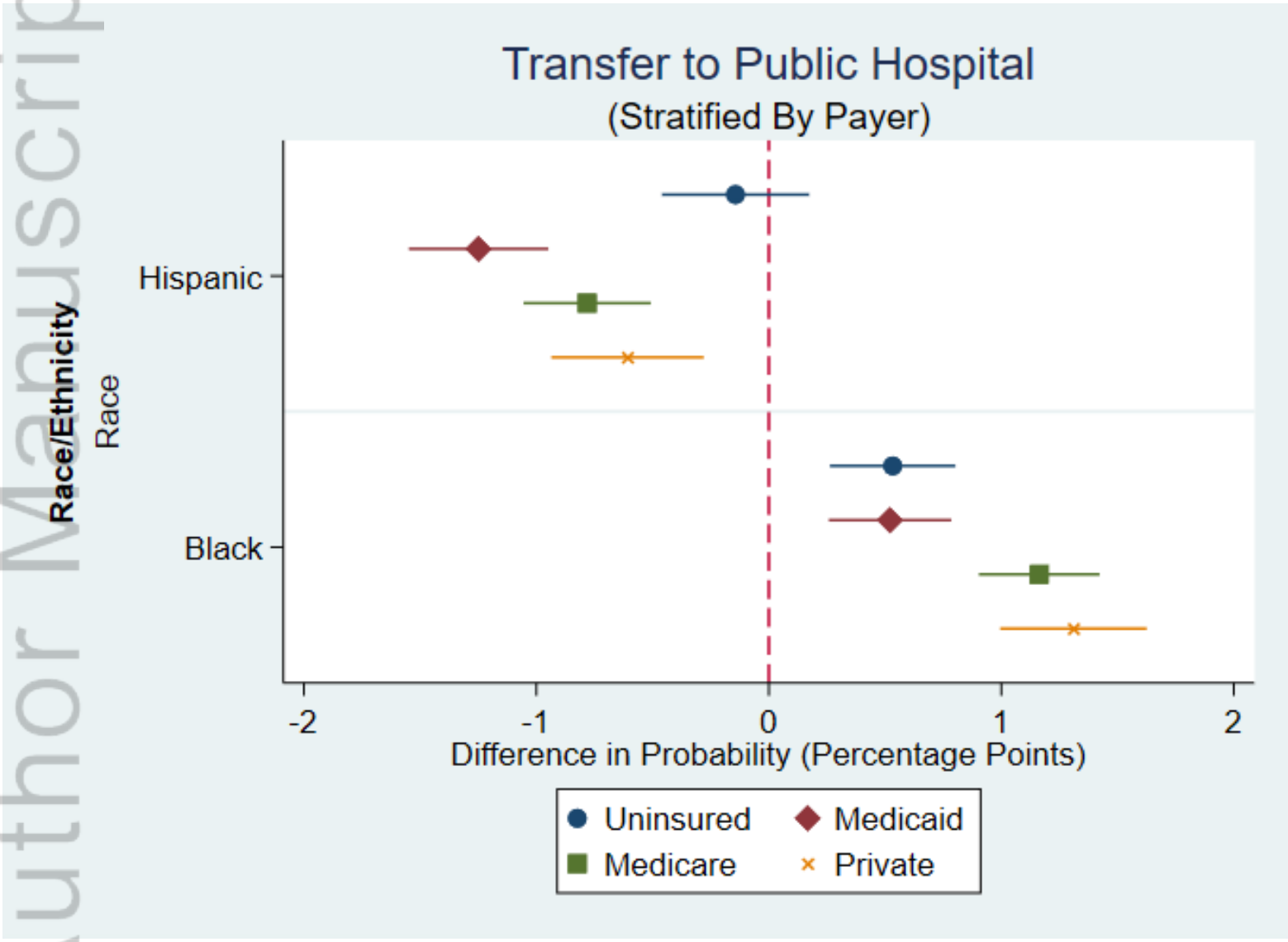
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