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Racial/ethnic and socioeconomic variations in hospital length of stay

A state-based analysis

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Abstract

Disparities by race/ethnicity and socioeconomic status (SES) exist in rehospitalization rates and inpatient mortality rates. Few studies have examined how length of stay (LOS, a measure of hospital efficiency/quality) differs by race/ethnicity and SES.

This study's objective was to determine whether differences in risk-adjusted LOS exist by race/ethnicity and SES

Using a retrospective cohort of 1,432,683 medical and surgical discharges, we compared risk-adjusted LOS, in days, by race/ethnicity and SES (median household income by patient ZIP code in quartiles), using generalized linear models controlling for demographic and clinical factors, and differences between hospitals and between diagnoses.

White patients were on average older than both Black and Hispanic patients, had more chronic conditions, and had a higher inpatient mortality risk. In adjusted analyses, Black patients had a significantly longer LOS than White patients (0.25-day difference when discharged to home and 0.23-day difference when discharged to non-home destinations, both P<.001); there was no difference between Hispanic and White patients. Wealthier patients had a shorter LOS than poorer patients (0.16-day difference when discharged to home and 0.06-day difference when discharged to nonhome destinations, both P<.001). These differences by race/ethnicity reversed for Medicaid patients.

Disparities in LOS exist based on a patient's race/ethnicity and SES. Black and poorer patients, but not Hispanic patients, have longer LOS compared to White and wealthier patients. In aggregate, these differences may be related to trust and implicit bias and have implications for use of LOS as a quality metric. Future research should examine the drivers of these disparities.

Abbreviations: AIC = Akaike Information Criteria, CMS = Center of Medicare and Medicaid Services, DRG = diagnosis-related group, HCUP = Healthcare Cost and Utilization Project, LOS = length of stay, RDI = racial/ethnic diversity index, SES = socioeconomic status.

Keywords: disparities, hospital, length of stay, race, socioeconomic status

1. Introduction

In the United States, variations in medical care and lost productivity related to race/ethnicity and socioeconomic status (SES) cost an estimated $309 billion per year.[1] Racial/ethnic and SES disparities exist in rehospitalization rates,[2] short- and long-term mortality rates,[3] and discharge destination for both surgical[4] and medical diagnoses.[5] Several factors may underlie these differences, such as patient factors (e.g., health care literacy and trust in the health care system),[6] provider factors (e.g., the culture of care),[7] and structural factors related to access to care.[8] Less well understood is the role the hospitals have in this variation; in particular, it is not clear how hospitals allocate

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resources and streamline care delivery and discharge planning to improve patient flow, and whether these procedures are conducted at the expense of vulnerable patients.[9]

Length of stay (LOS) – the time a patient spends in hospital from admission to discharge – is considered to be a measure of quality and efficiency of hospital processes.[10] LOS has clinical implications for the patient and financial implications for the hospital. Clinically, LOS directly correlates with risk of iatrogenic error[11] and hospital-acquired conditions.[12] Financially, LOS is reflective of the actual hospital resource utilization and costs, and, depending on the insurance type, might add to patients' copayments.

Since 2015, LOS has been used as a quality metric for physician payment. The Center of Medicare and Medicaid Service's (CMS) Value-Based Payment Modifier Program includes LOS as a metric to reward or penalize physician payments under the Medicare Physician Fee Schedule.[13] To enable meaningful comparison, LOS is adjusted for the patient's age, gender, and number of comorbidities using data from the Health care Utilization and Cost Project's (HCUP) National Inpatient Sample.

However, several other immutable factors may play a role in a patient's LOS, including a patient's race/ethnicity and SES. Studies have shown race/ethnicity and SES play a confounding role in LOS for patients admitted with heart failure, elective colectomy, and child birth.[14–16] However, these studies have been limited by their single-institution and payor-group focus. Whether racial/ethnic differences in LOS extend more broadly to all patients hospitalized for medical and surgical reasons regardless of insurance type is unclear, but may have implications for the patients themselves, the hospitals in terms of their resource allocation, and physicians in terms of their payment.

Therefore, we sought to systematically examine the relationship between hospital LOS and race/ethnicity and SES using a comprehensive data file of medical and surgical admissions. We hypothesized that after adjusting for patient, disease, and inter-hospital factors, LOS differs between White and non-White patients, and between poorer and wealthier patients, regardless of whether the patient is discharged to home or elsewhere.

2. Methods

2.1. Data source

To build a file of inpatient discharges with patient, disease, and social characteristics, we merged the 2014 New York State Inpatient Database from HCUP created by the Agency of Healthcare Research and Quality, with the 2014 American Hospital Association Annual Survey and the 2014 CMS Diagnosis-Related Group (DRG) listing. CMS currently categorizes diagnoses into medical and surgical DRGs. However, we wanted the categorization to reflect common diagnostic groupings by ward type. Two authors (AKG, BPG – both practicing clinicians) individually categorized all patient DRGs into 5 non-mutually exclusive groups based on the ward where patients are treated (i.e., medical, surgical, obstetrics/gynecology, psychiatry, and rehabilitation). Differences were discussed until consensus on the appropriate categorization was reached (Supplement). This research was approved by the institutional review board of Weill Cornell Medical College. All data were de-identified.

2.2. Study cohort

The study population consisted of nonhomeless patients, 18 years of age or older, discharged alive with a medical or surgical diagnosis in 2014 from an acute care hospital. We included patients whose hospital stay was greater than or equal to 1 day, even though the CMS Two-Midnight Rule came into effect, given the congressionally-mandated delay in the rule's enforcement.[17] We excluded observations categorized as obstetrics/gynecology, psychiatry, and rehabilitation DRGs; discharges from critical access hospitals because of their federally mandated LOS requirements to maintain an annual average patient LOS < 96 hours;[18] discharges from hospitals which lacked any minority patients; and homeless patients. We identified hospitals that lacked minority patients using a racial/ethnic diversity index (RDI), for which we divided the number of non-White admissions by the number of all patients admitted in 2014. We excluded hospitals with an RDI = 0 (i.e., hospitals that admitted only White patients) because these hospitals lacked diversity to allow LOS comparison between racial/ethnic groups. In total this excluded 1 hospital and 17 observations from the analysis. We excluded homeless individuals, identified using an available indicator variable in the HCUP dataset, for 2 reasons: first, their social characteristics differ from nonhomeless patients, which influences both LOS and discharge destination; and second, we did not have data to define the SES of homeless patients.

2.3. Study outcome

Our study outcome was risk-adjusted LOS in days. Specifically, we compared the difference in mean estimated risk-adjusted LOS

1. Between White, Black, Hispanic, and Other (Native American, Asian, Pacific Islander, and Other) patients who were discharged to home, and in separate analyses who were discharged to non-home destinations; and
2. Between patients in the poorest SES quartile (1st quartile of median household income by patient ZIP code) and those in the wealthiest SES quartile (4th quartile) who were discharged to home, and in separate analyses who were discharged to nonhome destinations.

Race/ethnicity were categorized according to the standardized HCUP classification. As a result, patients with Hispanic ethnicity were categorized as Hispanic regardless of their race (i.e., White vs Black vs Other).[19]

2.4. Models, study variables, and statistical analysis

We created 2 models which both employed LOS as the dependent variable. The first used race/ethnicity as the exposure variable and the second used SES. Both models operationalized our evidence-based conceptual framework which outlined relationships between patient, hospital, and clinical factors and patient LOS (Supplement). The control variables used were age, sex, health insurance status and type, weekend admission, urgency of admission (elective, urgent, or emergent), and time of year (time-quarter). We also controlled for the number of chronic diseases on admission using International Classification of Disease-9 codes on presentation, and the Elixhauser-related mortality score for each observation using a methodology described elsewhere.[20]

For continuous variables, we summarized descriptive analyses using means and standard deviations or medians and interquartile ranges (IQR) where appropriate. We used percentages with categorical variables. We assessed differences between racial/ethnic groups across the range of covariates using ANOVA and Chi-Squared tests where appropriate.

For both models, we employed multivariate generalized linear models, treating LOS as a gamma-distributed dependent variable because of its non-negative, right-skewed distribution.[21] For each model, we used patient-level control variables in line with the conceptual framework. Then, a race/ethnicity-SES interaction term was added to both models to investigate effect modification between race/ethnicity and SES. In the 2 separate models, we added interactions between race/ethnicity-discharge destination and SES-discharge destination to explain the racial/ethnicity and SES differences in LOS for patients discharged to home and to non-home destinations. Interaction terms in both models were significant. A fixed effect for each hospital and each DRG was introduced to account for the hospital and DRG-related differences.[22] Models were checked for multicollinearity using the variation inflation factor. Standard errors were clustered around each hospital. Although we preferred to calculate standard errors using bootstrapping methods, the number of observations made this computationally infeasible. Complete model specifications are provided in the Supplement.

We calculated the adjusted LOS differences by race/ethnicity and by SES using the *margins* command in STATA on each model. This allowed us to predict the mean adjusted LOS in days based on the previously fit models after averaging out the control variables in the model. A two-sided α of 0.05 was used throughout. Analysis was performed in STATA (Version 16) and R (version 3.5.2).

We reported the findings of our analysis by discharge destination (discharge to home vs discharge to non-home destinations) because clinically, patients being discharged to non-home destinations are typically sicker and require longer LOS in hospital. Moreover, the discharge process to non-home destinations requires administrative tasks such as insurance verification which may extend a patient's stay in hospital.

2.5. Sensitivity analysis

We performed 2 additional analyses. In the first, we excluded hospitals with less than 10% of their admissions coming from non-White patients (RDI < 0.1), and then less than 25% (RDU < 0.25). Second, we analyzed admissions by public insurance type (Medicare and Medicaid – managed care and fee-for-service). Given the means-tested nature of Medicaid, we employed only the race/ethnicity model for this patient cohort.

3. Results

3.1. Baseline characteristics

Our cohort consisted of 1,432,683 discharges. On average, White patients were older than Black, Hispanic, and Other patients (63.4 years vs 57.7, 57.4, and 59.7 years, respectively, $P < .001$); were less likely to be women compared with Black and Hispanic, though not Other, patients (51.2% vs 53.6%, 51.5%, and 47.8%, respectively; $P < .001$); were more likely to be wealthier (4th quartile) than Black, Hispanic, and Other patients (31.6% vs 10.4%, 13.7%, and 22.0%, respectively; $P < .001$); and were more likely to have private insurance than Black, Hispanic, and Other patients (27.2% vs 19.4%, 17.3%, and 23.3%, respectively; $P < .001$). The proportion of White patients admitted as emergencies was lower than the proportion of Black, Hispanic, and Other patients (72.5% vs 84.6%, 85.0%, and 77.2%, respectively; $P < .001$). The proportion of White patients admitted on weekends was lower than the proportion of Black, Hispanic, and Other patients (19.5% vs 21.3%, 21.6%, and 20.0%, respectively; $P < .001$). On average, White patients had more chronic conditions than Black, Hispanic, and Other patients (5.9 vs 5.5, 5.0, and 5.0, respectively; $P < .001$) and a higher Elixhauser-related mortality score (5.0 vs 4.5, 3.8, and 4.5, respectively; $P < .001$).

Median unadjusted LOS was the same for all groups (4 days) except Hispanic patients (3 days). More White patients were discharged to non-home destinations compared with Black, Hispanic, and Other patients (26.2% vs 23.1%, 17.6%, and 20.6%, respectively; $P < .001$). White patients had a higher proportion of surgical admissions compared to Black, Hispanic, and Other patients (30.0% vs 19.3, 22.6%, and 27.4%, respectively) (Table 1). Overall, lower joint replacement (DRG 470) and septicemia/severe sepsis (DRG 871) were the most common surgical and medical DRGs, respectively (Table 2).

3.2. Estimated mean LOS by race, SES, and discharge destination

The models used to evaluate the mean adjusted LOS by race and SES had the same goodness-to-fit measure, as determined by the Akaike Information Criteria (AIC), where $AIC_{MODEL\text{-}RACE} = AIC_{MODEL\text{-}SES} = 5.09$. Table 3 shows the estimated mean risk-adjusted LOS and discharge destination by race and by SES using both models. Compared with White patients, Black patients had a 0.25-day increase in risk-adjusted LOS when discharged to home (4.98 vs 5.23 days, $P < .001$) and a 0.23-day increase in risk-adjusted LOS when discharged to nonhome destinations (6.74 vs 6.97 days, $P < .001$), while Other patients had a 0.04-day increase in risk-adjusted LOS when discharged to home (4.98 vs 5.01 days, $P < .001$) and a larger 0.18 day increase when discharged to nonhome destinations (6.74 vs 6.92 days, $P < .001$). However, the difference in risk-adjusted LOS between Hispanic and White patients was non-significant for those discharged to either home (4.98 vs 4.96 days, $P > .05$) or non-home destinations. Compared with patients in the wealthiest SES quartile, patients in the poorest SES quartile had a 0.16-day increase in risk-adjusted LOS when discharged to home (4.92 vs 5.09 days, $P < .001$), and a narrower 0.06 day increase when discharged to nonhome destinations (6.77 vs 6.83 days, $P < .001$).

3.3. Results from sensitivity analysis

Outcomes comparing LOS and discharge destination by race and SES were not affected by excluding less racially diverse hospitals or limiting the population to Medicare patients (Supplement). Furthermore, for Medicaid patients discharged to nonhome destinations, differences in risk-adjusted LOS between White, Black, and Hispanic patients were non-significant.

However, for Medicaid patients discharged to home, non-White patients had a shorter risk-adjusted LOS (Table 4). Compared to White Medicaid patients, Black Medicaid patients on average spent 0.04 fewer days in hospital (5.54 vs 5.50 days, $P < .001$), Hispanic Medicaid patients spent 0.19 fewer days (5.54 vs 5.35 days, $P < .001$), and Other Medicaid patients spent 0.11 fewer days (5.54 vs 5.43 days, $P < .001$).

Table 1

Baseline demographic and clinical characteristics of the study cohort by race/ethnicity.

	Race/ethnicity				
	White	Non-White			
		Black	Hispanic	Other	*P* value
Discharges, (%)	855,971 (59.7)	243,934 (17.0)	151,637 (10.6)	181,141 (12.6)	<.001
Age, mean (sd)	63.4 (18.1)	57.7 (17.8)	57.4 (18.7)	59.71 (18.5)	<.001
Female, %	51.2	53.6	51.5	47.8	<.001
Quartile of median income by patient zip code, %					<.001
Quartile 1 (poorest)	14.5	50.6	45.9	31.5	
Quartile 2	26.4	18.2	19.7	23.8	
Quartile 3	27.5	20.8	20.7	22.7	
Quartile 4 (wealthiest)	31.6	10.4	13.7	22.0	
Chronic conditions, mean (sd)	5.9 (3.2)	5.5 (3.2)	5.0 (3.3)	5.0 (3.1)	<.001
Elixhauser-related mortality score, mean (sd)	5.0 (9.3)	4.5 (9.2)	3.8 (8.6)	4.5 (8.9)	<.001
Admitted on weekend, %	19.5	21.3	21.6	20.0	<.001
Admission type, %					<.001
Emergency	72.5	84.6	85.0	77.2	
Urgent	6.9	3.4	2.7	5.1	
Elective	20.2	11.8	11.9	17.3	
Trauma	0.3	0.2	0.4	0.5	
Insurance, %					<.001
Medicare	57.8	44.1	41.2	41.6	
Medicaid	10.4	30.1	34.1	28.5	
Private Insurance	27.2	19.4	17.3	23.3	
Self-Pay	2.1	3.5	5.0	4.3	
Other	2.4	2.8	2.4	2.2	
DRG type, %					<.001
Attributed to medical wards	72.7	83.2	79.6	75.5	
Attributed to surgical wards	30.0	19.3	22.6	27.4	
Length of Stay in days, median (IQR)	4 (4)	4 (5)	3 (4)	4 (4)	<.001
Discharge destination, %					<.001
Home	73.8	76.9	82.4	79.4	
Non home	26.2	23.1	17.6	20.6	
Time period discharged, %					
Q1: January to March	24.5	24.9	25.1	24.7	<.001
Q2: April to June	25.3	25.3	25.0	26.3	
Q3: July to September	25.1	25.0	24.9	25.0	
Q4: October to December	25.1	24.9	25.0	24.1	

1 For categorical variables, a Chi-Squared test was used to assess differences between groups; for continuous variables, ANOVA was used.
2 Some DRGs may be considered both medical and surgical in nature (see supplement).
3 Other category includes Asian-Pacific Islander, Native American, and Other races.

4. Discussion

In this large sample of patients admitted for inpatient care in 2014 in New York, we found small but statistically significant difference in LOS by race/ethnicity and SES after controlling for differences in patient demographics, disease states, diagnoses, and hospitals. Specifically, we found a significant increase in risk-adjusted LOS for Black patients regardless of discharge destination, but no difference between Hispanic when compared to White patients. Conversely, racial/ethnic differences in LOS switched among Medicaid patients, where White patients had a significantly longer LOS than Black, Hispanic, and Other patients when discharged to home. Separately, in our assessment of SES and LOS, we found a persistent difference in risk-adjusted LOS between wealthier and poorer patients for both discharge to home, and to nonhome destinations.

Our findings reflect the existing literature on the role of race/ethnicity and SES on LOS in large datasets. Analyses of colorectal surgical data from the 2012 to 2013 National Surgical Quality Improvement Project demonstrated, after adjustment for surgical type, comorbidities, patient demographics, and lab values, an almost 1 day difference in mean adjusted LOS for Black patients compared to White, Hispanic, and Asian patients.[15] Similar findings were noted comparing Black and White patients undergoing anterior cervical discectomy using the HCUP National Inpatient Sample,[23] and between Black and White patients boarded in emergency rooms awaiting transition toward using the National Hospital Ambulatory Care Survey. Similarly, several studies have demonstrated the association between poorer SES (measured with proxies such as insurance status, income and employment, or area deprivation indices) and disparities in LOS in the general hospital population,[24,25] in stroke patients,[26] in patients undergoing elective hip replacement,[27] and after trauma.[28]

However, 2 findings from our analysis are striking for their counterintuition. The first is that despite a lower risk-adjusted LOS compared with all minority groups other than Hispanics, White patients were older, sicker, and at higher risk of inpatient mortality. This finding differs from several studies which have consistently demonstrated an association between the number of comorbidities and longer LOS.[29–31] One possible explanation

Table 2

Top ten medical and surgical Diagnosis-related Groupings (DRGs) by volume, New York State, 2014.

Medical DRGs

DRG	Title	Total volume	Percent[1]
871	SEPTICEMIA OR SEVERE SEPSIS W/O MV 96+ HOURS W MCC	42,587	3.9
897	ALCOHOL/DRUG ABUSE OR DEPENDENCE W/O REHABILITATION THERAPY W/O MCC	42,030	3.9
392	ESOPHAGITIS, GASTROENT & MISC DIGEST DISORDERS W/O MCC	40,248	3.7
603	CELLULITIS W/O MCC	26,645	2.5
313	CHEST PAIN	23,172	2.1
292	HEART FAILURE & SHOCK W CC	22,113	2.0
872	SEPTICEMIA OR SEVERE SEPSIS W/O MV 96+ HOURS W/O MCC	21,191	2.0
690	KIDNEY & URINARY TRACT INFECTIONS W/O MCC	19,310	1.8
312	SYNCOPE & COLLAPSE	18,219	1.7
247	PERC CARDIOVASC PROC W DRUG-ELUTING STENT W/O MCC	17,617	1.6

Surgical DRGs

DRG	Title	Total volume	Percent[2]
470	MAJOR JOINT REPLACEMENT OR REATTACHMENT OF LOWER EXTREMITY W/O MCC	57,863	5.3
621	O.R. PROCEDURES FOR OBESITY W/O CC/MCC	12,606	1.2
460	SPINAL FUSION EXCEPT CERVICAL W/O MCC	11,194	1.0
330	MAJOR SMALL & LARGE BOWEL PROCEDURES W CC	8,722	0.8
419	LAPAROSCOPIC CHOLECYSTECTOMY W/O C.D.E. W/O CC/MCC	8,262	0.8
481	HIP & FEMUR PROCEDURES EXCEPT MAJOR JOINT W CC	7,322	0.7
473	CERVICAL SPINAL FUSION W/O CC/MCC	6,713	0.6
853	INFECTIOUS & PARASITIC DISEASES W O.R. PROCEDURE W MCC	6,595	0.6
343	APPENDECTOMY W/O COMPLICATED PRINCIPAL DIAG W/O CC/MCC	6,008	0.6
494	LOWER EXTREM & HUMER PROC EXCEPT HIP, FOOT,FEMUR W/O CC/MCC	5,606	0.5

[1] As percent of total medical DRGs.
[2] As percent of total surgical DRGs.

here may be the underdiagnosis and/or underreporting of comorbidities in claims data for minority populations, reflecting differences in health access, and the quality of care between White and non-White patients – a well-recognized issue.[32]

The second counterintuitive finding relates to a reverse of LOS disparities between racial/ethnic groups in the Medicaid population. While it is unclear what is driving these differences, Medicaid expansion may play a role. Under the Affordable Care Act, New York State expanded Medicaid on January 1, 2014. This changed the threshold for eligibility to adults with incomes up to 138% of the federal poverty level. Angier et al show that by race/ethnicity, White patients who enrolled in Medicaid within expansion states were older and had more comorbidities compared with both Hispanic and Black patients.[33] Our model adjusted for age, the number of chronic comorbidities, and the Elixhauser mortality score. Therefore, differential rates of comorbidity between newly enrolled White and non-White Medicaid patients, particularly Hispanic patients, may explain this LOS discrepancy as an artifact of risk-adjustment.

Concerningly, our findings may also reflect issues of trust in the health care system, or implicit bias on part of the treating team.[6,34,35] Implicit bias has become increasingly recognized as a driver of health care disparities. Furthermore, decisions related to discharge involve a mutual agreement that leaving the hospital is in the interest of the patient. If communication fails or the patient/treating team relationship sours, the resultant tension may prevent timely discharge decisions, lengthening LOS. The subconscious nature of trust and implicit bias in health care may explain the persistent difference in LOS between Black and White patients because of current and historical realities affecting Black Americans.[36] This may further explain the non-significant LOS differences seen between Hispanic and White patients.

Our findings have policy implications for patients, physicians, and hospitals. For patients, these findings suggest that Black, Other, and poorer patients may incur added risk of nosocomial infections. However, on average this risk may be low and represent an added exposure of only 4 to 6 hours in a hospital. For physicians, however, whose Medicare reimbursement has been tied to LOS as a quality metric, the case may be different.[13] Value-based physician reimbursement payment models, using qualified clinical data registries, do employ risk adjustment.[37] However, those models adjust only for age, DRG type (DRG severity weighting), and comorbidities. Our analysis demonstrates that LOS is longer for poorer patients and minority patients (except Hispanic patients), suggesting that in aggregate, physicians serving minority populations are at higher risk of being penalized financially. Lastly, our findings indicate that hospitals with more Black and low SES patients incur longer LOS for their patients going home: for every 4 Black patients or every 7 low SES patients, LOS increases by approximately 1 day. Given the importance of patient flow and timely discharge in maintaining operational efficiency, these hospitals are disadvantaged by reduced revenue opportunities due to longer patient stays. This may lead to attempts by hospitals to discharge patients to less ideal nonhome destinations rather than home, leading to increased downstream direct and indirect costs related to postacute care, decreased patient satisfaction, and increased rehospitalization risk.

This study has several limitations. First, our findings may not be generalizable nationally since we focused on discharges from New York State. Nonetheless, New York represents a large, diverse state of almost 20 million.[38] Second, we lacked detailed individual-level social factors. Our measure of SES is imprecise and unlikely to capture the nuances of socioeconomic risk.

Table 3

Estimated mean risk-adjusted LOS by race/ethnicity, SES, and discharge destination.

Discharge home

	Mean risk-adjusted LOS (days)[1]	95% CI[1]	Difference (days)[1]	95% CI (difference)[1]
Race/ethnicity[2]				
White (Reference)	4.98	4.96 to 4.99	-	-
Black	5.23	5.20 to 5.25	0.25	0.24 to 0.26*
Hispanic	4.96	4.93 to 4.99	−0.01	−0.03 to 0.0
Other	5.01	4.99 to 5.04	0.04	0.03 to 0.05*
SES[3]				
Quartile 1 (Reference) [poorest]	5.09	5.07 to 5.11	-	-
Quartile 2	5.07	5.05 to 5.08	-0.02	−0.02 to −0.02*
Quartile 3	5.01	4.99 to 5.03	-0.08	-0.08 to -0.07*
Quartile 4 [wealthiest]	4.92	4.90 to 4.94	−0.16	−0.17 to −0.16*

Discharge to nonhome destinations

	Mean risk-adjusted LOS (days)[1]	95% CI[1]	Difference (days)[1]	95% CI (difference)[1]
Race/ethnicity				
White (Reference)	6.74	6.71 to 6.77	–	–
Black	6.97	6.91 to 7.03	0.23	0.19 to 0.26*
Hispanic	6.77	6.68 to 6.85	0.02	−0.03 to 0.08
Other	6.92	6.85 to 6.99	0.18	0.14 to 0.22*
SES				
Quartile 1 (reference) [poorest]	6.83	6.78 to 6.88	–	–
Quartile 2	6.77	6.73 to 6.81	−0.06	−0.06 to −0.05*
Quartile 3	6.85	6.80 to 6.89	0.02	0.02 to 0.03*
Quartile 4 [wealthiest]	6.77	6.73 to 6.81	−0.06	−0.07 to -0.05*

1. Rounded to 2 decimal places.
2. Model used to calculate mean adjusted LOS employed a generalized linear model with gamma-distributed dependent variable which controlled for race, discharge disposition (home vs non-home), interaction for race and discharge disposition, age, sex, interaction between race and socioeconomic status (defined as median income by patient ZIP code by quartile), health insurance status and type, indicator variable for weekend admission, urgency of admission, time-quarter, with individual intercepts for diagnosis-related group and hospital.
3. Model used to calculate mean adjusted LOS employed a generalized linear model with gamma-distributed dependent variable which controlled for socioeconomic status (defined as median income by patient ZIP code by quartile), discharge disposition (home vs non-home), interaction for race and discharge disposition, age, sex, interaction between race and socioeconomic status, health insurance status and type, indicator variable for weekend admission, urgency of admission, time-quarter, with individual intercepts for diagnosis-related group and hospital.
* Difference is significant.

However, neighborhood SES remains an indirect proxy of individual SES.[39] Third, we did not employ physician-level fixed effects in our model due to dimensionality constraints. While physicians are critical to patient care, a team of health professionals makes discharge-related decisions, which moderates the physician role. Fourth, we employed DRG fixed effects as disease controls rather than individual diagnoses using International Classification of Disease codes. While DRGs are imprecise

Table 4

Estimated mean risk-adjusted LOS by race/ethnicity, SES, and discharge destination for Medicaid-insured patients.

Discharge home

	Mean risk-adjusted LOS (days)[1]	95% CI[1]	Difference (days)[1]	95% CI (difference)[1]
Race/ethnicity[2]				
White (Reference)	5.54	5.56 to 5.61	–	–
Black	5.50	5.42 to 5.58	−0.04*	−0.04 to −0.04
Hispanic	5.35	5.28 to 5.42	−0.19*	−0.19 to −0.19
Other	5.43	5.36 to 5.51	−0.11*	−0.11 to −0.11

Discharge to non-home destinations

	Mean risk-adjusted LOS (days)[1]	95% CI[1]	Difference (days)[1]	95% CI (difference)[1]
Race/ethnicity[2]				
White (Reference)	6.54	6.37 to 6.72	–	–
Black	6.54	6.32 to 6.77	0.00	−0.05 to 0.05
Hispanic	6.52	6.15 to 6.89	−0.02	−0.21 to 0.17
Other	6.58	6.28 to 6.88	0.04	−0.08 to 0.16

1. Rounded to 2 decimal places.
2. Model used to calculate mean adjusted LOS employed a generalized linear model with gamma-distributed dependent variable which controlled for race, discharge disposition (home vs non-home), interaction for race and discharge disposition, age, sex, interaction between race and socioeconomic status (defined as median income by patient ZIP code by quartile), health insurance status and type, indicator variable for weekend admission, urgency of admission, time-quarter, with individual intercepts for diagnosis-related group and hospital.
* Difference is significant.

tools to determine diagnoses, they represent thematically linked diagnosis categories which allowed a study of LOS at ward- and hospital-level.

5. Conclusion

We sought to explain the relationship between race/ethnicity, SES, and LOS. Our analyses highlight small but meaningful differences in how inpatient care is delivered to vulnerable populations in each hospital. They suggest that in aggregate these differences may systemically impact reimbursement for physicians caring for underserved populations. They further suggest that these differences may distort efficiencies in hospitals serving diverse patient populations and contribute to the cascade of indirect effects on the care of vulnerable patient populations downstream. Future research should seek to understand the drivers of these disparities, whether these disparities in risk-adjusted LOS change over time, and the resulting financial impact on hospitals serving vulnerable populations.

Author contributions

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