ORIGINAL RESEARCH

Racial Disparities in Hospitalization Among Patients Who Receive a Diagnosis of Acute Coronary Syndrome in the Emergency Department

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BACKGROUND: Timely hospitalization of patients who are diagnosed with an acute coronary syndrome (ACS) at the emergency department (ED) is a crucial step to lower the risk of ACS mortality. We examined whether there are racial and ethnic differences in the risk of being discharged home among patients who received a diagnostic code of ACS at the ED and whether having health insurance plays a role.

METHODS AND RESULTS: We examined 51 022 910 discharge records of ED visits in Florida, New York, and Utah in the years 2008, 2011, 2014, and 2016/2017 using state-specific data from the Healthcare Cost and Utilization Project. We identified ED admissions for acute myocardial infarction or unstable angina using the *International Classification of Diseases, Ninth Revision* (*ICD-9*)/*International Statistical Classification of Diseases, Tenth Revision* (*ICD-10*) diagnostic codes. We used generalized estimating equation models to compare the risk of being discharged home across racial and ethnic groups. We used Poisson marginal structural models to estimate the mediating role of health insurance status. The proportion discharged home with a diagnostic code of ACS was 12% among Black patients, 6% among White patients, 9% among Hispanic patients, and 9% among Asian/Pacific Islander patients. The incidence risk ratio for being discharged home was 1.26 (95% CI, 1.18–1.34) in Black patients, 1.23 (95% CI, 1.15–1.32) in Hispanic patients, and 1.11 (95% CI, 0.93–1.31) in Asian/Pacific Islander patients compared with White patients. Race and ethnicity were marginally associated with discharge home via pathways not mediated by health insurance.

CONCLUSIONS: Racial and ethnic disparities exist in the hospitalization of patients who received a diagnostic code of ACS in the ED. Possible causes need to be investigated.

Key Words: acute coronary syndrome ■ emergency department ■ Florida ■ New York ■ patient discharge ■ racial and ethnic disparities ■ Utah

Each year, >800 000 individuals experience acute coronary syndromes (ACS) in the United States.[1] According to guideline recommendations, health care providers at the emergency department (ED) should risk-stratify patients based on the likelihood of ACS to decide on the need for hospitalization[2–4] as timely hospitalization is a critical step in ACS treatment, resulting in better health outcomes.[5]

Racial disparities have been reported in ACS mortality and redmissions[6–8] as well as in the evaluation of chest pain and test ordering at the first presentation of ACS.[9,10] Previous studies also reported missed diagnoses of ACS and acute myocardial infarction (AMI) in the ED,[11–15] drawing attention to diagnostic errors in health care delivery.[15,16] More than 20 years ago, one of these studies suggested that the risk of not being

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CLINICAL PERSPECTIVE

What Is New?

- In state-specific data of 51 022 910 discharge records of emergency department (ED) visits in Florida, New York, and Utah, Black and Hispanic patients were more likely to be discharged home with a diagnostic code of acute coronary syndrome after their visit to the ED compared with White patients.
- Among patients aged <55 years, Black, Hispanic, and Asian/Pacific Islander patients were almost twice as likely to be discharged home after receiving an ED diagnostic code of acute myocardial infarction than their White counterparts.
- Race and ethnicity directly influence discharge from the ED via pathways not mediated by health insurance. Other possible factors to explain this association need to be investigated.

What Are the Clinical Implications?

- Our findings suggest that racial disparities exist in the hospitalization of acute coronary syndrome at the ED, which are especially marked among younger patients.
- These results should inform hospital quality improvement programs to reduce or even eliminate racial differences in the clinical care for acute coronary syndrome.

Nonstandard Abbreviations and Acronyms

GEE	generalized estimating equation
HCUP	Healthcare Cost and Utilization Project
IRR	incidence risk ratio
UA	unstable angina

admitted with an ACS was >4 times higher among Black patients, Hispanic patients, and other patients of color than White counterparts.[12] Also, although there is extensive literature on missed diagnoses in the ED,[11–15] avoidable admissions to hospitals, and the overuse of emergency care,[17–19] only a few studies have examined disparities in hospitalization among ED patients who were diagnosed with ACS.[11–15] Most studies were conducted in small study populations >2 decades ago. Examining whether racial differences still exist in a modern, real-world setting by using a large, population-level, contemporary database could illuminate new opportunities to improve health care delivery for all.

In this study, we aimed to examine whether there are racial differences in the risk of discharge home among individuals who present to the ED and receive a diagnostic code of AMI or unstable angina (UA) using an all-payer database. Furthermore, because a retrospective analysis of a previous clinical trial reported significant sex differences in the risk of missed diagnoses of AMI in the ED among patients aged <55 years,[12] we tested for "race and ethnicity and age" and "race and ethnicity and sex" interactions. Also, because health insurance coverage can be an important determinant of access to health care,[20] we examined the role of health insurance as a mediator in these associations.

METHODS

Independent Data Access and Analysis Statement

Dr Islek had full access to all the data in the study and takes responsibility for their integrity and the data analysis.

Study Population

We analyzed data from the linkable State Inpatient Databases and the State Emergency Department Databases of the Healthcare Cost and Utilization Project (HCUP).[21] The databases include all-payer, encounter-level information from nonfederal hospitals and have been widely used in previous studies.[22–25] The data sets used for this study cannot be made available to other researchers based on the Data Use Agreement with the HCUP, Agency for Healthcare Research and Quality.

We examined data from Florida, New York, and Utah for the years 2011, 2014, and 2016/2017 and additionally 2008 for Utah. We chose these states because they are populous, large, and geographically distributed and provided data at the patient level. To link ED visits with subsequent hospitalizations, we merged the ED and inpatient discharge files using unique encrypted patient numbers.

In total, we examined 51 022 910 patient-level ED discharge records for the whole period. Among these records, there were 222 619 records with a discharge code of AMI and 55 830 records with a discharge code of UA. For the identification of AMI, we used the *International Classification of Diseases, Ninth Revision* (*ICD-9*) codes of 410.0 through 410.9 as the primary diagnostic code and *International Statistical Classification of Diseases, Tenth Revision* (*ICD-10*) codes of I21.0 to I21.02, I21, I21.1 to I21.4, I21.11, I21.21, I21.29, I24.8, I21A, I21.A1, and I21.A9. For the identification of UA, we used the primary *ICD-9* codes of 411.1, 411.8, and 411.89 and the *ICD-10* codes of I25.110, I12.00, and I12.0. We first identified and excluded duplicate records attributed to transfers from one hospital to another of the same patient (n=14 738) to isolate the initial

ED visits for each patient. Transfers between hospitals for the same event were counted as a single admission. From the remaining 263 711 patient-level visits for an AMI or UA, we excluded records of patients who left the ED against medical advice (n=2500), who died (n=1252), who had chronic coronary heart disease (CHD) (n=3150), whose discharge was planned under court/law enforcement (n=22), who were missing discharge status (n=50), who were missing the race variable (n=2742), who had duplicate records (n=4464), or who were of unspecified minority groups (n=12 570) (Figure 1). We identified patients who had chronic CHD using the *ICD-9* codes 412, 414.8, and 414.9 and the *ICD-10* codes I25.2 and I25.9.

Definition of Race and Ethnicity and Outcomes

The race and ethnicity variable used in this study was derived from the HCUP database and included the following 4 groups: non-Hispanic White patients, non-Hispanic Black patients, Hispanic patients, and Asian/Pacific Islander patients. Information on race and ethnicity was provided by state-level databases and was combined by the HCUP into a single race and ethnicity variable, giving ethnicity precedence over race. This classification was used in previous analyses using HCUP data.[23] For example, if a patient was of the Black racial group and Hispanic ethnicity, then he or she was classified as a member of the "Hispanic" racial and ethnicity group. Because Hispanic people can be of any race, the Hispanic group in this study included Hispanic people of all races.

The primary outcome was being discharged home directly from the ED with a primary diagnostic code for AMI and UA. The outcome was classified as "discharged home" for patients who were admitted to an ED observation unit if they were not hospitalized and did not get care from hospital inpatient services.

Definition of Covariates

We considered those who had Medicare, Medicaid, private, and other insurance as "insured" and those who self-paid as "uninsured" in mediation analysis. Other covariates included age, sex, median household income quartile, and urban/rural location. The median household income quartile and urban/rural location were defined and reported by HCUP based on the patient's ZIP code.

Statistical Analysis

First, we tabulated the distributions of baseline sociodemographic factors of patients discharged home and those hospitalized with an ED diagnostic code of AMI or UA overall and by race and ethnicity. We used

Pearson χ^2 tests to compare distributions of demographic characteristics for dichotomous (sex, location of residence) or nominal (race and ethnicity, income quartile, insurance type, geographic state) variables and Student's *t* test for means of age between 2 groups of patients who were hospitalized or discharged home. Next, we computed risks and 95% CIs of being discharged home with a diagnostic code of AMI and UA by race and ethnicity.

In Model 1, we used generalized estimating equations (GEEs), which accounted for clustering of patients within individual hospitals, using unique hospital identifiers and a Poisson link. For GEE models, we used robust (sandwich) variance estimators while specifying an independent correlation matrix structure. We compared the risk of being discharged home with a diagnostic code of AMI or UA between White and Black patients and Hispanic and Asian/Pacific Islander patients. Model 1 is adjusted for age, sex, and state when the model is constructed among the patients with a diagnosis code of AMI and UA. To avoid confounding by diagnosis (either AMI or UA), we also adjusted for the diagnosis itself when we constructed Model 1 among all patients.

Next, we did a mediation analysis, where we hypothesized that health insurance is a mediating factor on the pathway between race and ethnicity and being discharged home after the ED visit. We constructed a Poisson marginal structural model (Model 2) using inverse probability weighting[26,27] to avoid violation of a major mediation analysis assumption,[28] which requires that there should not be any mediator-outcome confounders affected by the exposure.[28] As seen in Figure 2, because race and ethnicity, as the exposure, is an upstream variable, there could be a path (path 1) from race and ethnicity to income, urban/rural residence, state. These 3 variables could be confounders of the association between health insurance and discharge home (through paths 2 and 5). Therefore, simply adjusting for all covariates in the models could result in biased results for mediation analysis. The use of methods such as inverse probability weighting, which allows separating the effect of health insurance from the effect of other covariates, is recommended to get more accurate estimates.[26,29] Using this approach, we estimate the effect of race through pathways "1*2" and "3," conceptually removing paths "4" and "5" in Figure 2. We additionally created a Poisson model (model 3) that adjusts for all covariates except health insurance to compare our results with model 2. It is not possible to adjust for the clustering of patients in hospitals in the Poisson marginal structural model approach. Therefore, we chose to construct a regular Poisson model as model 3, rather than a GEE model, to make model 2 and model 3 comparable. In model 4,
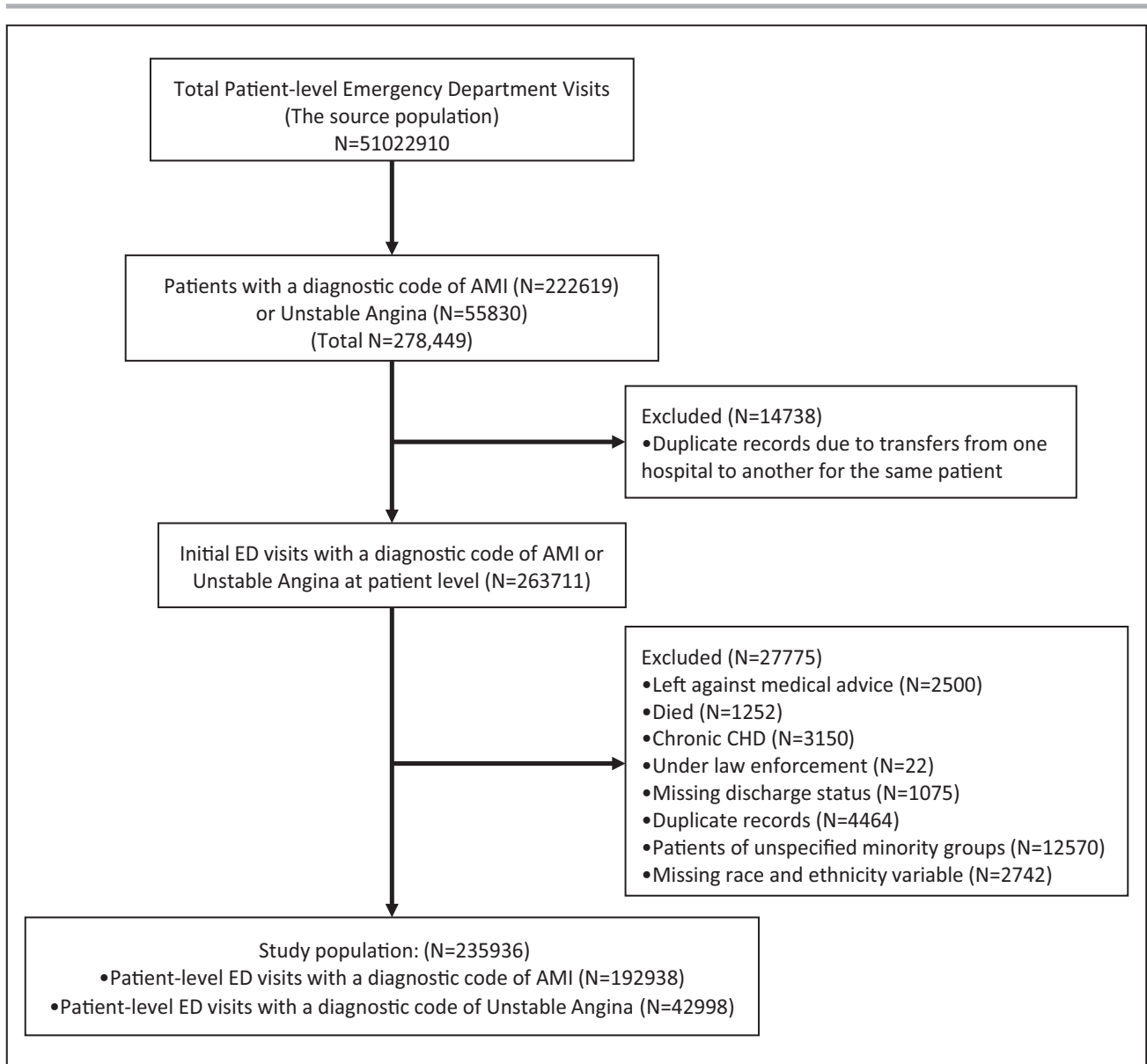
Figure 1. Profile of the study population obtained from the Healthcare Cost and Utilization Project State Databases of Florida, New York, and Utah in the years 2008, 2011, 2014, and 2016/2017.
AMI indicates acute myocardial infarction; CHD, coronary heart disease; and ED, emergency department.

we created a Poisson model and included health insurance as a categorical covariate (Medicare, Medicaid, private, and other insurance or noninsured) to test whether our conclusions would remain similar because previous studies reported that health insurance status explained racial disparities in the evaluation of chest pain at the ED both among publicly insured and noninsured patients.[9,10,30] Furthermore, we tested "race and ethnicity and age" and "race and ethnicity and sex" interactions in models 1, 2, 3, and 4. Because the "race and ethnicity and age" and "race and ethnicity and sex" interactions were consistently significant for ACS and AMI patients in all models, we reran models 1, 2, 3, and 4 after stratifying the data by age (aged <55 years

and aged ≥55 years) and sex. Finally, to investigate the possible consequences of an improper ED discharge, we examined the risk of readmission within 30 days among those discharged home after their initial ED visit with a diagnostic code of ACS.

In a sensitivity analysis, we repeated the mediation analysis by reclassifying those who had "Medicaid" as "uninsured" because patients with Medicaid tend to be a socioeconomically disadvantaged group and are often underinsured. Also, to address a possible misclassification of patients with chronic CHD as being mistakenly assigned a diagnostic code of AMI or UA in the ED, we examined racial and ethnic differences among those excluded as a result of having a code of chronic CHD.
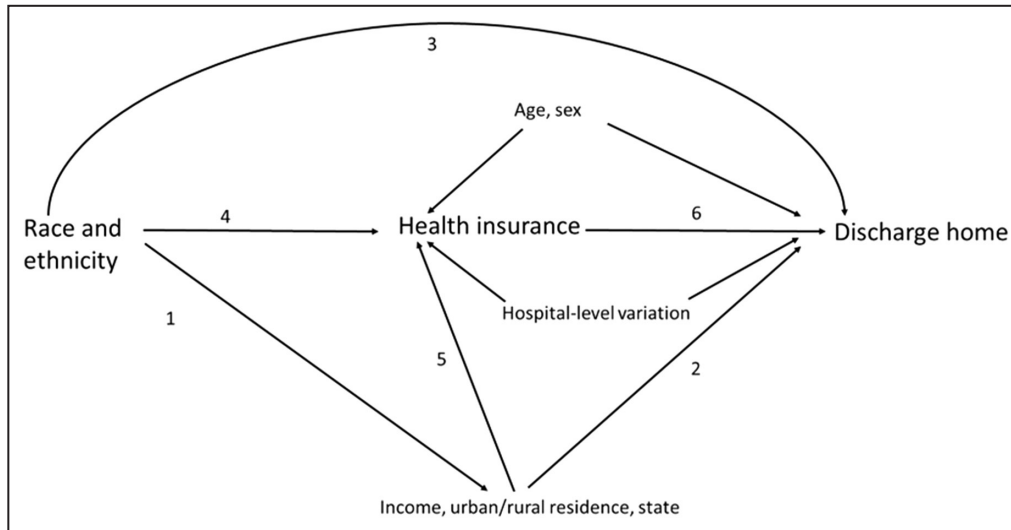
Figure 2. Directed acyclic graph as a conceptual model demonstrating the associations between race and ethnicity, being discharged home, health insurance, and other covariates.

Because significant sex differences in the risk of missed diagnoses of AMI in the ED among patients aged <55 years was previously reported,[12] we conducted a secondary analysis to examine whether these sex differences also exist for discharge home with a diagnostic code of ACS from the ED among patients aged <55 years in our study.

We used administrative data with synthetic person identifiers. No human subjects were involved, and no institutional review board approval was required. All data cleaning and analysis methods used were consistent with the Health Insurance Portability and Accountability Act[31] privacy rules. All analyses were performed with SAS 9.4 (Cary, NC).

RESULTS

Of the 192 938 patients who received a diagnostic code of AMI in the ED, 4117 (2.1%) were discharged home, and of the 42 998 patients who received a diagnostic code of unstable angina, 12 513 (29.1%) were discharged home. The patients who were discharged home were more likely to be younger and had less health insurance coverage than those who were hospitalized. Income distribution and location of residence, however, were similar (Table 1). Results were fairly consistent when examined with race and ethnicity (Tables S1 and S2).

Among the 235 936 patients who visited the ED and received a diagnostic code of ACS (either AMI or UA), the proportion being discharged home was 11.6% among Black patients, which was the highest proportion of all racial groups. The corresponding figures were 5.9% among White patients, 8.9% among Hispanic

patients, and 8.6% among Asian/Pacific Islander patients (Table 2). In age- and sex-adjusted GEE models, the incidence risk ratio (IRR) for being discharged home was 1.26 (95% CI, 1.18–1.34) in Black patients and 1.23 (95% CI, 1.15–1.32) in Hispanic patients compared with White patients (model 1, Table 2). Differences were smaller and nonsignificant among Asian/Pacific Islander patients. When AMI and UA were examined separately, a larger proportion of patients in all race and ethnicity groups were discharged home after a diagnostic code of UA than after a diagnostic code of AMI, but the differences for Black patients compared with White patients were larger for AMI than for UA (Table 2). Race and ethnicity was marginally associated with discharge home from the ED via pathways not mediated by health insurance in the entire sample and among AMI and UA subgroups (model 2, Table 2), and the results remained consistent after health insurance was removed from the model (model 3, Table 2). Our conclusions did not change after health insurance was added as a categorical covariate to the model (model 4, Table 2).

In model 1, there were significant race and ethnicity and age interactions among the total sample of patients with ACS (P=0.003) and among patients with AMI (P<0.001), but not among patients with UA (P=0.728). Interaction results remained similar in models 2, 3, and 4. The estimates from the age-stratified Poisson marginal structural models are shown in Figure 3. In patients aged <55 years, the risk of being discharged home with an AMI was higher among all racial groups compared with White patients in the Poisson marginal structural models (Figure 3). The magnitude of IRRs was especially high among Hispanic versus White patients (IRR, 1.99 [95% CI, 1.72–2.29]) and among Black patients

Table 1. Characteristics of Patients Who Visited the Emergency Department With an Acute Coronary Syndrome in Florida, New York, and Utah in the Years 2008, 2011, 2014, and 2016/2017

	AMI (N=192 938)		P value	Unstable angina (N=42 998)		P value
	Discharged home (N=4117) (2.1%)	Hospitalized (N=188 821) (97.9%)		Discharged home (N=12 513) (29.1%)	Hospitalized (N=30 485) (70.9%)	
Age, y, mean (SD)	60.7 (19.9)	68.7 (14.3)	<0.001	61.8 (14.2)	64.3 (13.6)	<0.001
Sex (% men)	2446 (59.4)	114 325 (60.6)	<0.001	7218 (57.7)	18 313 (60.1)	<0.001
Race and ethnicity, n (%)			<0.001			<0.001
White patients	2824 (68.6)	141 196 (74.8)		7212 (57.6)	19 704 (64.6)	
Black patients	629 (15.2)	20 967 (11.1)		2875 (23.0)	5659 (18.6)	
Hispanic patients	599 (14.6)	23 547 (12.5)		2123 (17.0)	4329 (14.2)	
Asian or Pacific Islander patients	65 (1.6)	3111 (1.7)		303 (2.4)	793 (2.6)	
Income quartile, n (%)			<0.001			<0.001
First quartile (lowest)	1253 (30.4)	55 997 (30.3)		4403 (35.7)	9682 (32.5)	
Second quartile	1281 (31.1)	55 014 (29.8)		3344 (27.1)	8382 (28.2)	
Third quartile	914 (22.2)	41 600 (22.5)		2455 (19.9)	6165 (20.7)	
Fourth quartile (highest)	594 (14.4)	32 074 (17.4)		2115 (17.2)	5521 (18.6)	
Insurance type, n (%)			<0.001			<0.001
Medicare	1880 (46.4)	116 753 (62.6)		6595 (53.1)	17 180 (56.8)	
Medicaid	486 (12.0)	14 494 (7.8)		1742 (14.0)	3889 (12.9)	
Private insurance	1185 (29.3)	40 919 (21.9)		3074 (24.7)	7020 (23.2)	
Self-pay	369 (9.1)	9787 (5.2)		666 (5.4)	1319 (4.4)	
Other	130 (3.2)	4526 (2.4)		350 (2.8)	826 (2.7)	
Location of residence, n (%)			<0.001			<0.001
Urban	2408 (58.5)	113 510 (60.3)		8349 (66.9)	19 462 (64.0)	
Rural	1702 (41.3)	74 686 (39.7)		4127 (33.1)	10 925 (36.0)	
Geographic state, n (%)			<0.001			<0.001
Florida	2414 (58.7)	113 057 (59.8)		6921 (55.3)	14 909 (48.9)	
New York	1397 (34.0)	68 044 (36.0)		5255 (42.0)	14 625 (48.0)	
Utah	306 (7.3)	7720 (4.2)		337 (2.7)	951 (3.1)	

AMI indicates acute myocardial infarction.

versus White patients (IRR, 1.90 [95% CI, 1.66–2.17]). In contrast, among patients aged ≥55 years, there were no racial differences in risk of being discharged home after an ED diagnostic code for AMI. For UA, the results were similar by age (Figure 3). Again, health insurance did not play any role as a mediator in these associations. These conclusions remained similar when models 1, 3, and 4 were also stratified by age.

In model 1, there were significant race and ethnicity and sex interactions among the total sample of patients with ACS (P=0.006) and among patients with AMI (P=0.001), but not among patients with UA (P=0.146). The significance of the interactions remained the same in models 2, 3, and 4. The estimates from the sex-stratified Poisson marginal structural models are shown in Figure 4. Among women, the risk of being

discharged home with an AMI was higher for Black patients (IRR, 1.33 [95% CI, 1.03–1.71]) and Hispanic patients (IRR, 1.33 [95% CI, 1.03–1.71]) compared with their White counterparts in the Poisson marginal structural models (Figure 4). The magnitude of the racial disparities was slightly lower among men. Results were similar by sex for UA (Figure 4). Race and ethnicity directly influenced discharge home from the ED via pathways not mediated by health insurance. Again, these conclusions remained similar when models 1, 3, and 4 were stratified by sex.

In sensitivity analyses, our conclusions also remained the same after we reclassified those who had "Medicaid" as "uninsured." There were no racial and ethnic differences in hospitalization among 3099 patients who visited the ED and were excluded from our

Table 2. Association of Race and Ethnicity With Being Discharged Home With a Diagnostic Code of Acute Coronary Syndrome After the Emergency Department Visit in Florida, New York, and Utah in the Years 2008, 2011, 2014, and 2016/2017

	Total (N=235936)			
	White patients	Black patients	Hispanic patients	Asian or Pacific Islander patients
Total patients (n)	170936	30130	30598	4272
Patients sent home (n)	10036	3504	2722	368
Proportion, %	5.9	11.6	8.9	8.6
Model 1,* IRR (95% CI)	REF	1.26 (1.18–1.34)	1.23 (1.15–1.32)	1.11 (0.93–1.31)
Model 2,† IRR (95% CI)	REF	1.26 (0.71–2.24)	1.23 (0.86–1.74)	1.11 (0.47–2.63)
Model 3,‡ IRR (95% CI)	REF	1.24 (1.15–1.35)	1.24 (1.13–1.36)	1.09 (0.91–1.29)
Model 4,§ IRR (95% CI)	REF	1.19 (1.14–1.24)	1.20 (1.15–1.26)	1.07 (0.96–1.19)
	Patients with a diagnostic code of AMI (N=192938)			
	White patients	Black patients	Hispanic patients	Asian or Pacific Islander patients
Total patients (n)	144020	21596	24146	3176
Patients sent home (n)	2824	629	599	65
Proportion, %	2.0	2.9	2.5	2.0
Model 1,* IRR (95% CI)	REF	1.42 (1.22–1.65)	1.27 (1.08–1.48)	1.06 (0.69–1.64)
Model 2,† IRR (95% CI)	REF	1.29 (1.04–1.59)	1.22 (1.01–1.47)	1.03 (0.69–1.52)
Model 3,‡ IRR (95% CI)	REF	1.39 (1.18–1.65)	1.35 (1.10–1.64)	1.11 (0.75–1.64)
Model 4,§ IRR (95% CI)	REF	1.25 (1.14–1.37)	1.27 (1.15–1.39)	1.05 (0.81–1.35)
	Patients with a diagnostic code of unstable angina (N=42998)			
	White patients	Black patients	Hispanic patients	Asian or Pacific Islander patients
Total patients (n)	26916	8534	6452	1096
Patients sent home (n)	7212	2875	2123	303
Proportion, %	26.8	33.7	32.9	27.6
Model 1,* IRR (95% CI)	REF	1.23 (1.16–1.30)	1.23 (1.15–1.31)	1.13 (0.97–1.32)
Model 2,† IRR (95% CI)	REF	1.23 (1.15–1.33)	1.23 (1.13–1.33)	1.18 (0.99–1.41)
Model 3,‡ IRR (95% CI)	REF	1.22 (1.15–1.29)	1.22 (1.14–1.30)	1.09 (0.96–1.24)
Model 4,§ IRR (95% CI)	REF	1.20 (1.14–1.26)	1.20 (1.14–1.26)	1.01 (0.97–1.23)

AMI indicates acute myocardial infarction; IRR, incident risk ratio; and REF, reference.

*Model 1 is a generalized estimating equation model with a Poisson link, accounting for clustering of patients in hospitals, using robust (sandwich) variance estimators with an independent correlation matrix structure and adjusted for age, sex, state, and diagnosis (only for total patients).

†Model 2 is a Poisson marginal structural model adjusted for age, sex, state, income quartile, urban/rural location of residence, and diagnosis (only for total events). Health insurance is included as a mediator to the model. Inverse probability weighting method is applied.

‡Model 3 is a Poisson model adjusted for age, sex, state, income quartile, urban/rural location of residence, and diagnosis (only for total patients).

§Model 4 is a Poisson model adjusted for age, sex, health insurance (categorized as Medicare, Medicaid, private insurance, self-pay, and other), state, income quartile, urban/rural location of residence, and diagnosis (only for total patients).

analysis as a result of having a diagnosis of chronic CHD. In secondary analyses examining sex differences, the risk of being discharged home was 1.57 (95% CI, 1.35–1.82) times higher in women versus men aged <55 years in patients with a diagnostic code of AMI. Sex differences were attenuated but were still significant among patients who received a diagnostic code of UA. There were no sex differences in patients aged >55 years (Table S3).

Among the patients discharged home with a diagnostic code of ACS in their initial visit to the ED, 412 patients (2.5%) returned to the ED within 30 days and received another diagnostic code of ACS. This proportion was higher in Black patients (3.2%) than White patients (2.1%) (P<0.001). Also, compared with White patients (2.1%), the proportion returning to the ED was higher in Hispanic patients (2.6%) (P=0.097) and Asian patients (2.4%) (P=0.633), although these differences were not statistically significant. Among Black patients, 61.1% of those returning to the ED and receiving a diagnostic code of ACS were ultimately hospitalized, whereas the corresponding hospitalization proportions were lower in the other groups, especially among White patients (32.1%) (P<0.001) (Table S4).
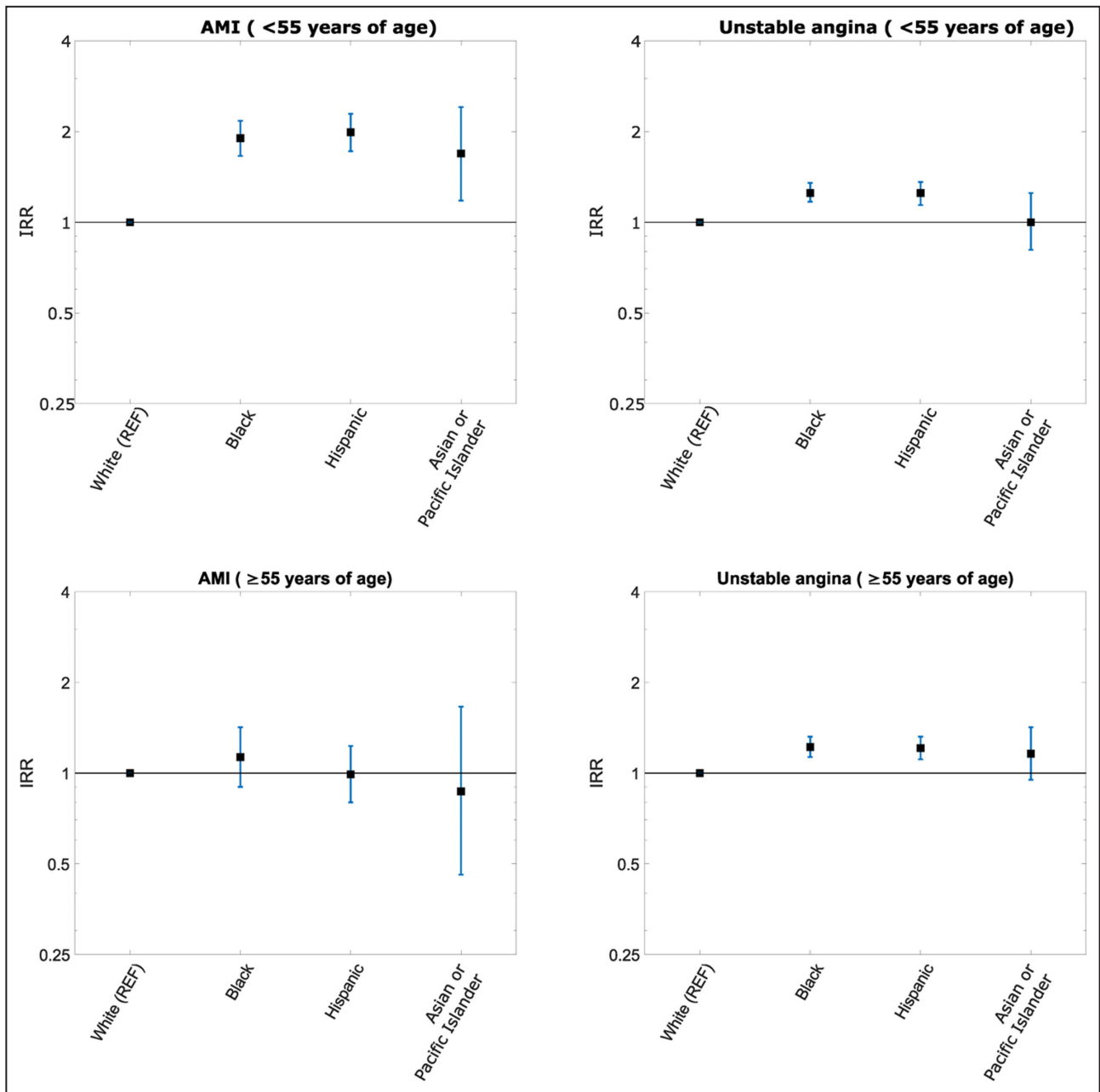
Figure 3. Association of race and ethnicity with being discharged home with a diagnostic code of acute coronary syndrome after the emergency department visit by age.
Poisson marginal structural model adjusted for sex, state, income quartile, urban/rural location of residence were used to estimate the IRR. Health insurance is included as a mediator to the model. Inverse probability weighting method is applied. AMI indicates acute myocardial infarction; IRR, incidence risk ratio; and REF, reference.

DISCUSSION

In this study, Black and Hispanic patients were more likely to be discharged home with a diagnostic code of ACS after their visit to the ED compared with White patients. In contrast, differences were small in Asian/Pacific Islander patients versus White patients. However, among patients aged <55 years, Black, Hispanic, and Asian/Pacific Islander patients were almost twice as likely to be discharged home after receiving an ED diagnostic code of AMI than their White counterparts.

Our results support and expand those of prior studies, which reported that approximately 2% of patients with AMI were discharged home from the ED.[12,14] Our findings also align with previous data suggesting that underrepresented racial and ethnic patients with AMI were more likely to be discharged home than White
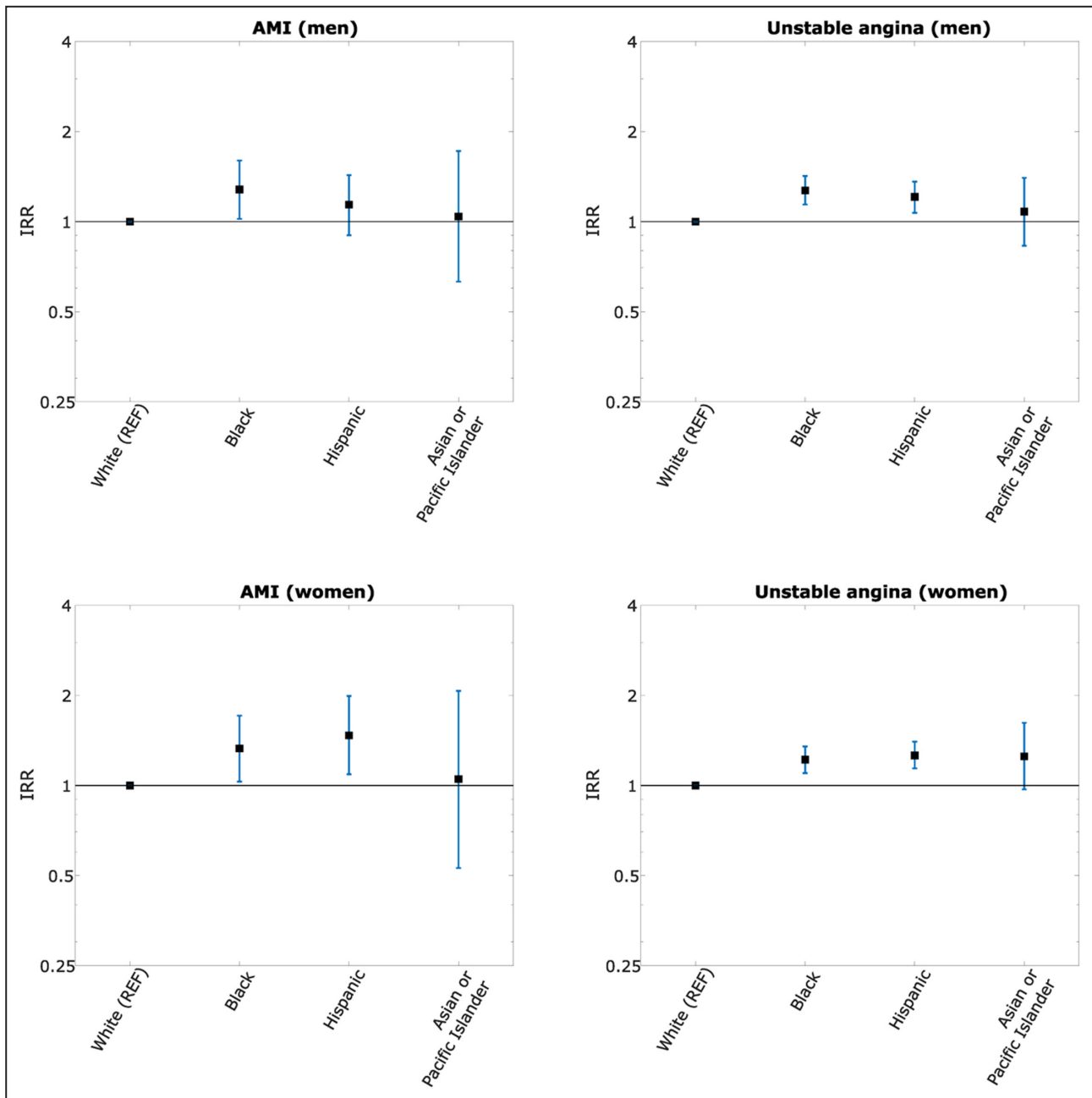
Figure 4.   Association of race and ethnicity with being discharged home with a diagnostic code of acute coronary syndrome after the emergency department visit by sex.
Poisson marginal structural model adjusted for age, state, income quartile, and urban/rural location of residence were used to estimate the IRRs. Health insurance is included as a mediator to the model. Inverse probability weighting method is applied. AMI indicates acute myocardial infarction; IRR, incidence risk ratio; and REF, reference.

patients.[12] However, the discharge rate for UA was higher in our analysis compared with the discharge rate of UA in one of these prior studies where UA diagnosis was adjudicated.[12] This might be possibly related to improvements in cardiac biomarker assays in the decades between these two studies or to the fact that UA diagnoses were not adjudicated in the current study. Also, in these previous studies, patients were

discharged home because of a missed diagnosis. In our study, we used diagnostic codes that likely represent a heterogeneous group. Patients who received a diagnostic code of AMI could include patients with type 1 or type 2 AMIs as well as patients with myocardial injury not meeting the strict definition for an AMI. It may be possible that patients with type 2 AMI or myocardial injury may be appropriately discharged from the ED

depending on the clinical context. However, this would not explain the racial and ethnic differences observed in this study. Racial and ethnic bias can still influence decision making because subjective assessment is still important even when using evidence-based decision aids. Another possible explanation may rely on errors in the coding of AMI in ED records, as the tendency of overusing a code of AMI was reported several decades ago.[32] However, the validity of an AMI code as a principal diagnosis has been shown to be high in administrative databases in more contemporary studies,[33–35] which suggests that our findings cannot be entirely explained by coding errors of AMI either. Furthermore, if miscoding were an issue, it would likely not be differential by race and ethnicity, and thus it would result in attenuation, rather than overestimation, of the race and ethnicity differences we found. Moreover, our finding that Black patients had the highest risk of returning to the ED within 30 days with a repeat diagnostic code of ACS (whereas White patients had the lowest risk) also argues against coding errors. More Black patients were ultimately hospitalized at their second ED visit. These points suggest that more hospitalizations for ACS were truly overlooked for Black patients than other groups at their first ED encounter.

One might argue that variability in health care and coding patterns across hospitals, rather than patients' race and ethnicity, may be the driving factors in the differences in missed hospitalizations we describe.[36] Previous studies suggested that the proportion of missed diagnoses in patients with AMI varied across the hospital's academic status,[37] and the patient distribution by race and ethnicity is known to vary by hospital.[38,39] A previous study reported that Black patients were more likely to be admitted to hospitals with high mortality compared with White patients.[40] We accounted for the clustering of patients within hospitals in our GEE models (model 1) to account for the influence of hospital characteristics. Therefore, it is unlikely that differences in individual-level hospital characteristics explain our findings.

One other explanation could be related to implicit racial biases in the clinical decision making of health care providers.[41,42] Previous studies suggested that the race of a patient can influence how physicians manage patient care.[43,44] However, we did not have data to assess whether physician implicit bias existed in this study. Prior studies have also suggested that low-income patients are more likely to refuse care even when offered, resulting in lower admission rates to hospitals with ACS.[45] However, because we excluded the patients who left the ED against medical advice and also adjusted for income quartiles in some of our models, these factors are unlikely to explain our results completely. On the other hand, it should be considered that patient preferences for discharge

and opportunities for outpatient management can influence the decision making among physicians for patients when there is an uncertain diagnosis. We might have missed these situations by only excluding those who left against medical advice.

Prior studies reported that health insurance status explained racial disparities in the evaluation of chest pain at the ED and in outcomes of ACS.[9,10,30] Given that the availability of health insurance is also closely associated with health care access,[20,46] we had hypothesized that health insurance coverage would at least partially explain the associations between race and ethnicity and being discharged home with a diagnostic code of ACS. Surprisingly, we found that this was not the case. Further investigations should examine other factors associated with racial differences in access to hospitalization among patients presenting with ACS in the ED.

Our study has several strengths. We used a database that captures all ED visits for ACS in nonfederal facilities for a diverse group of states and years. Therefore, we were able to avoid possible selection bias related to patients selecting certain health care facilities versus others based on their insurance status.[47] Also, we included Asian/Pacific Islander patients and patients from all age groups in our analysis, which allowed us to improve on findings of previous studies that were based on smaller populations with more limited race and ethnicity distributions[12] or Medicare populations only, which primarily include patients aged ≥65 years.[37,48]

Our study also has some limitations. HCUP data files are administrative data sets that do not provide information on clinical findings or other cardiovascular risk factors during the ED visit. We used the primary diagnostic codes to identify ED visits for AMI and UA and could not verify the diagnosis with ECG findings or blood test results. To minimize misclassification, we excluded patients with chronic CHD using *ICD-9* or *ICD-10* codes. However, this information was also subject to the physician's coding behavior, and we might have missed some patients with chronic CHD if the physician chose not to record this information. There was no available information on multiracial individuals, and race and ethnicity information was not self-reported as recommended by recent guidelines for disparities research.[49,50] Instead, it was provided by the individual states (the data sources of HCUP), which could have been subject to misclassification.[51] Unfortunately, we did not have any information on the patients who could not obtain a hospital bed because of hospital overcrowding and were therefore discharged while still physically in the ED although they would have been hospitalized otherwise. Also, we considered all patients as discharged home if they were not hospitalized and did not get care from hospital inpatient services.

However, some patients with UA or low-risk AMI might have received care from ED observation or chest pain units. Unfortunately, we did not have information on this type of setting. Finally, Black patients are known to have more cardiovascular risk factors than their White counterparts.[52] This should make them more likely, rather than less likely, to be admitted as opposed to discharged compared with White patients. However, because reliable data on these factors were not available, we were not able to include them in our models. Even in this respect, it is likely that our findings on racial differences are conservative.

In conclusion, based on our findings, racial disparities exist in the hospitalization of ACS at the ED, which are especially marked among younger patients. Our data suggest an important area for quality improvement in health care. Equal delivery of health care in the initial diagnosis and timely hospitalization of ACS are crucial to reduce mortality and eliminate racial disparities in health outcomes. Hospital quality improvement programs that aim to enhance hospital adherence to clinical care guidelines could reduce or even eliminate racial differences in guideline-recommended care for ACS.[53–55] Such programs should be prioritized by policymakers to minimize racial inequalities in the hospitalization rates for ACS.

ARTICLE INFORMATION

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Disclosures

None.

Supplemental Material

Table S1–S4.

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SUPPLEMENTAL MATERIAL

Table S1. Characteristics of patients who visited the Emergency Department and received a diagnostic code of acute myocardial infarction by race in FL, NY and UT, in years 2008, 2011, 2014 and 2016/7

	White individuals (N=144020)		Black Individuals (N=21596)		Hispanic Individuals (N=24146)		Asian individuals (N=3176)	
	Sent home (N=2824) (2.0 %)	Hospitalized (N=141179) (98.0 %)	Sent home (N=629) (2.9 %)	Hospitalized (N=20965) (97.1 %)	Sent home (N=599) (2.5 %)	Hospitalized (N=23546) (97.5 %)	Sent home (N=65) (2.0 %)	Hospitalized (N=3111) (98 %)
Age mean (SD) y	65.1 (16.5)	69.7 (14.1)	49.4 (21.6)	63.8 (49.4)	52.9 (24.2)	67.3 (14.4)	52.3 (24.5)	65.4 (13.9)
Sex (% men)	1742 (61.7)	86627 (61.4)	321 (51.0)	11103 (32.1)	339 (56.6)	14427 (61.3)	44 (67.7)	2156 (69.3)
Income quartile, n (%)								
1st quartile, lowest	706 (25.0)	35244 (25.0)	305 (48.5)	10609 (50.6)	231 (38.6)	9585 (40.7)	11 (16.9)	557 (17.9)
2nd quartile	924 (32.7)	43389 (30.7)	171 (27.2)	4563 (21.7)	174 (29.1)	6162 (26.2)	12 (18.5)	896 (28.8)
3rd quartile	670 (23.7)	33063 (23.4)	99 (15.7)	3127 (14.9)	122 (20.4)	4582 (19.5)	23 (35.4)	818 (26.3)
4th quartile, highest	465 (16.5)	26810 (19.0)	43 (6.8)	1944 (9.2)	67 (11.2)	2662 (11.3)	19 (29.2)	654 (21.0)
Insurance type, n (%)								
Medicare	1472 (52.1)	90655 (64.2)	178 (28.3)	11200 (53.4)	209 (34.9)	13552 (57.6)	21 (32.3)	1328 (42.7)
Medicaid	174 (6.2)	7020 (5.0)	157 (25.0)	3427 (16.3)	145 (24.2)	3238 (13.8)	10 (15.4)	808 (26.0)
Private insurance	829 (29.4)	31976 (22.7)	169 (26.9)	3963 (18.9)	163 (27.2)	4282 (18.2)	24 (36.9)	697 (22.4)
Self-pay	212 (7.5)	6580 (4.7)	92 (14.6)	1441 (6.9)	57 (9.5)	1550 (6.6)	8 (12.3)	216 (6.9)
Other	101 (3.6)	3523 (2.5)	19 (3.0)	623 (3.0)	8 (1.3)	347 (1.5)	0 (0.0)	33 (1.1)
Location of residence, n (%)								
Urban	1339 (47.4)	74426 (52.7)	502 (79.8)	15940 (76.3)	516 (86.1)	20400 (86.6)	51 (78.5)	2728 (87.7)
Rural	1479 (52.6)	66337 (47.3)	127 (20.2)	4945 (23.7)	82 (13.9)	3033 (13.4)	14 (21.5)	367 (12.3)
Geographic state								
FL	1652 (58.5)	83821 (59.4)	382 (60.7)	12152 (58.0)	361 (60.3)	16235 (69.0)	19 (29.2)	849 (27.3)
NY	900 (31.9)	50450 (35.7)	246 (39.1)	8758 (41.8)	211 (35.2)	6678 (28.4)	40 (61.5)	2138 (68.7)
UT	272 (9.6)	6908 (4.9)	1 (0.2)	55 (0.3)	27 (4.5)	633 (2.7)	6 (9.2)	124 (4.0)

Table S2. Characteristics of patients who visited the Emergency Department and received a diagnostic code of unstable angina by race in FL, NY and UT, in years 2008, 2011, 2014 and 2016/7

	White individuals (N=26916)		Black individuals (N=8534)		Hispanic individuals (N=6452)		Asian individuals (N=1096)	
	Sent home (N=7212) (26.8 %)	Hospitalized (N=19701) (73.2 %)	Sent home (N=2875) (33.7 %)	Hospitalized (N=5659) (66.3 %)	Sent home (N=2123) (32.9 %)	Hospitalized (N=4329) (67.1 %)	Sent home (N=303) (27.7 %)	Hospitalized (N=793) (72.4 %)
Age mean (SD) y	64.4 (13.6)	66.1 (13.0)	56.9 (14.2)	59.8 (14.1)	59.6 (14.2)	62.4 (13.8)	62.0 (14.6)	62.8 (12.9)
Sex (% men)	4392 (60.9)	12326 (62.6)	1467 (51.0)	2918 (51.6)	1186 (55.9)	2553 (59.0)	173 (57.1)	514 (64.8)
Income quartile, n (%)								
1st quartile, lowest	1845 (25.6)	5014 (25.5)	1570 (54.6)	2793 (49.4)	935 (44.0)	1764 (40.8)	53 (17.5)	111 (14.0)
2nd quartile	2107 (29.2)	6012 (30.5)	623 (21.7)	1133 (20.0)	541 (25.5)	1013 (23.4)	73 (24.1)	224 (28.3)
3rd quartile	1569 (21.8)	4257 (21.6)	406 (14.1)	876 (15.5)	406 (19.1)	807 (18.6)	74 (24.4)	223 (28.1)
4th quartile, highest	1557 (21.6)	4040 (20.5)	240 (8.4)	646 (11.4)	220 (10.4)	627 (14.5)	98 (32.3)	207 (26.1)
Insurance type, n (%)								
Medicare	4003 (55.5)	11703 (59.4)	1490 (51.8)	2925 (51.7)	984 (46.4)	2253 (52.0)	118 (38.9)	298 (37.6)
Medicaid	537 (7.5)	1369 (7.0)	632 (22.0)	1321 (23.3)	496 (23.4)	924 (21.3)	77 (25.4)	275 (34.7)
Private insurance	2054 (28.5)	5045 (25.6)	490 (17.0)	998 (17.6)	445 (21.0)	814 (18.8)	85 (28.1)	161 (20.3)
Self-pay	324 (4.5)	825 (4.2)	182 (6.3)	244 (4.3)	141 (6.6)	209 (4.8)	19 (6.3)	41 (5.2)
Other	254 (3.5)	613 (3.1)	59 (2.1)	127 (2.2)	34 (1.6)	76 (1.8)	3 (1.0)	10 (1.3)
Location of residence								
Urban	3949 (54.8)	10355 (52.6)	2309 (80.3)	4580 (80.9)	1813 (85.4)	3792 (87.6)	278 (91.8)	734 (92.6)
Rural	3248 (45.2)	9295 (47.4)	553 (19.7)	1059 (19.1)	304 (14.6)	513 (12.4)	22 (8.2)	56 (7.4)
Geographic state								
FL	4305 (59.7)	10132 (51.4)	1413 (49.2)	2464 (43.5)	1133 (53.4)	2184 (50.5)	70 (23.1)	129 (16.3)
NY	2641 (36.6)	8706 (44.2)	1456 (50.6)	3186 (56.3)	936 (44.1)	2097 (48.4)	222 (73.3)	633 (79.8)
UT	266 (3.7)	863 (4.4)	6 (0.2)	9 (0.2)	54 (2.5)	48 (1.1)	11 (3.6)	31 (3.9)

Table S3. Association of sex with being discharged home with a diagnostic code of acute coronary syndrome after the emergency department visit, stratified by age in FL, NY and UT, in years 2008, 2011, 2014 and 2016/7

Total				
Below 55 years old (N=49,376)			55 years and over (N=201,908)	
	Men	Women	Men	Women
Total patients (n)	34847	14529	117462	84446
Patients sent home (n)	3397	2129	6981	5374
Proportion %	9.7	14.7	5.9	6.4
Model 1*, IRR (95 % CI)	**REF**	1.19 (1.11 - 1.28)	**REF**	1.06 (1.01 - 1.12)
Model 2[†], IRR (95 % CI)	**REF**	1.24 (1.00 - 1.53)	**REF**	1.08 (0.85 - 1.36)
Model 3[‡], IRR (95 % CI)	**REF**	1.22 (1.53 - 1.29)	**REF**	1.07 (1.03 – 1.11)
Model 4[§], IRR (95 % CI)	**REF**	1.22 (1.15 – 1.29)	**REF**	1.09 (1.05 – 1.13)
Patients with AMI				
Below 55 years old (N= 37,253)			55 years and over (N= 167,655)	
	Men	Women	Men	Women
Total patients (n)	27153	10100	97,568	70087
Patients sent home (n)	860	516	1753	1265
Proportion %	3.2	5.1	1.8	1.8
Model 1*, IRR (95 % CI)	**REF**	1.57 (1.35 - 1.82)	**REF**	1.02 (0.91 - 1.15)
Model 2[†], IRR (95 % CI)	**REF**	1.67 (1.44 - 1.92)	**REF**	1.03 (0.93 - 1.13)
Model 3[‡], IRR (95 % CI)	**REF**	1.66 (1.48 – 1.86)	**REF**	1.01 (0.93 - 1.08)
Model 4[§], IRR (95 % CI)	**REF**	1.71 (1.52 – 1.91)	**REF**	1.07 (0.99 - 1.16)
Patients with Unstable angina				
Below 55 years old (N=12,123)			55 years and over (N=34,253)	
	Men	Women	Men	Women
Total patients (n)	7694	4429	19,894	14359
Patients sent home (n)	2537	1613	5,228	4109
Proportion %	33.0	36.4	26.3	28.6
Model 1*, IRR (95 % CI)	**REF**	1.09 (1.02 - 1.17)	**REF**	1.07 (1.02 - 1.13)
Model 2[†], IRR (95 % CI)	**REF**	1.11 (1.03 - 1.19)	**REF**	1.09 (1.03 - 1.16)
Model 3[‡], IRR (95 % CI)	**REF**	1.11 (1.05 - 1.19)	**REF**	1.09 (1.04 – 1.13)
Model 4[§], IRR (95 % CI)	**REF**	1.11 (1.04 - 1.18)	**REF**	1.10 (1.05 – 1.15)

Abbreviations: IRR: Incident risk ratio AMI: Acute myocardial infarction

*Model 1 is a GEE model, with a Poisson link, accounting for clustering of patients in hospitals, using robust (sandwich) variance estimators with an independent correlation matrix structure, and adjusted for age, race, state, and diagnosis (only for total patients)

[†] Model 2 is a Poisson marginal structural model adjusted for age, race, state, income quartile, urban/rural location of residence and diagnosis (only for total events). Health insurance is included as a mediator to the model. Inverse probability weighting method is applied.

[‡] Model 3 is a Poisson model adjusted for age, race, state, income quartile, urban/rural location of residence and diagnosis (only for total patients).

[§]Model 4 is a Poisson model adjusted for age, race, health insurance (categorized as Medicare, Medicaid, private insurance, self-pay and other), state, income quartile, urban/rural location of residence and diagnosis (only for total patients).

Table S4. Readmissions within 30 days among those discharged home with a diagnostic code of AMI or unstable angina in their initial visit to the ED visit in FL, NY and UT, in years 2008, 2011, 2014 and 2016/7

	White patients	Black patients	Hispanic patients	Asian or Pacific Islander patients
Patient sent home in the initial ED visit (n)	10036	3504	2722	368
Patients returned to the ED within 30 days (n)	209	113	71	9
Proportion (%)	2.1	3.2	2.6	2.4
Patients hospitalized in the second ED visit (n, %)	67 (32.1)	69 (61.1)	35 (49.3)	5 (55.6)