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Race and Sex Disparities in Prehospital Recognition of Acute Stroke

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Abstract

Objectives—The objective of this study was to examine prehospital provider recognition of stroke by race and sex.

Methods—Diagnoses at emergency department (ED) and hospital discharge from a statewide database in California were linked to prehospital diagnoses from an electronic database from two counties in Northern California from January 2005 to December 2007 using probabilistic linkage. All patients 18 years and older, transported by ambulances (n = 309,866) within the two counties, and patients with hospital-based discharge diagnoses of stroke (n = 10,719) were included in the study. Logistic regression was used to analyze the independent association of race and sex with the correct prehospital diagnosis of stroke.

Results—There were 10,719 patients discharged with primary diagnoses of stroke. Of those, 3,787 (35%) were transported by emergency medical services providers. Overall, 32% of patients ultimately diagnosed with stroke were identified prehospital. Correct prehospital recognition of stroke was lower among Hispanic patients (odds ratio [OR] = 0.77, 95% confidence interval [CI] = 0.61 to 0.96), Asians (OR = 0.66, 95% CI = 0.55 to 0.80), and others (OR = 0.71, 95% CI = 0.53 to 0.94), when compared with non-Hispanic whites, and in women compared with men (OR =

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Supporting Information:
The following supporting information is available in the online version of this paper:
Data Supplement S1. Sensitivity and specificity by race and sex.

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0.82, 95% CI = 0.71 to 0.94). Specificity for recognizing stroke was lower in females than males (OR = 0.84, 95% CI = 0.78 to 0.90).

Conclusions—Significant disparities exist in prehospital stroke recognition.

Despite recent advances in prevention and treatment, stroke remains a leading cause of morbidity and mortality within the United States.[1,2] Early recognition of acute stroke, with administration of intravenous (IV) thrombolytic within 4.5 hours of symptom onset, improves outcomes in all populations.[3–7] However, national rates of thrombolysis for acute ischemic stroke remain low (1%–5%).[8–10] As one of the crucial components of the American Heart/Stroke Association "Stroke Chain of Survival," emergency medical services (EMS) play an important role, providing early recognition of symptoms, rapid patient transport, and prearrival notification to receiving hospitals.[7,11,12] Prearrival notification to destination hospitals by EMS has been strongly associated with better in-hospital stroke time targets,[13–19] including physician evaluation, computed tomographic (CT) imaging, and increased rates of thrombolytic administration.[17–20] However, significant variability exists in prehospital stroke recognition and rates of prearrival notification, contributing to delays in treatment. While reasons for these differences are yet to be completely understood, optimization of provider education and training, use of validated stroke scales, priority transport to primary stroke centers, and prearrival notification have been identified as measures to improve prehospital stroke recognition.[21]

Our objective was to determine the contribution of patient factors, particularly sex and race, to prehospital stroke recognition. Investigation of prehospital disparities associated with stroke care has been secondarily reported in studies of factors delaying patient arrival to the hospital.[22–24] These studies have also observed higher rates of stroke mortality among minorities.[22] Additionally, in acute settings, treatment disparities in the form of lower IV tissue plasminogen activator use and unequal implementation of evidence-based care, have been shown in African American and, to a lesser extent, Hispanic patients.[22,25–30] Disparities have also been reported in the use of stroke prevention therapies such as endarterectomy and anticoagulation for atrial fibrillation.[22] In the prehospital setting, disparities have not been observed among stroke patients, but reduced scene times have been reported for male patients with ST-elevation myocardial infarction.[31] We examined the contributions of race, ethnicity, and sex to stroke recognition by prehospital providers in multiethnic communities in Northern California.

METHODS

Study Design

This was a cross-sectional observational study of subjects transported by prehospital providers. The Institutional Review Board and the Committee for Human Protection Subjects, State of California, approved the study.

Study Setting and Population

Transport was to hospitals within two counties in Northern California during 2005–2007. There are a total of 14 hospitals in the study counties: five received primary stroke center status in 2006, seven received primary stroke center certification in 2007, one received primary stroke center certification in 2008, and one did not have a date on file. Eligible subjects were ≥18 years of age, were transported by EMS providers to destination hospitals within study counties, and received discharge diagnoses of stroke (ICD-9 430–438, indicators of stroke like hemiplegia [342], paralysis [344], amaurosis fugax [362.34], transient visual loss [368.12], transient limb paralysis [781.41], aphasia [783.41], and dysphasia [783.5]) in the patient and emergency department (ED) abstract files of the Office of Statewide Health Planning and Development (OSHPD). We excluded patients with missing prehospital impression and/or hospital outcomes and interfacility transfers.

Study Protocol

The primary data sources for the study were the OSHPD discharge abstract files containing nonpublic ED discharge records and patient discharge records from the two study counties. Patients seen and discharged from the ED were included in the ED discharge database, and those who were admitted to the hospital through the ED were included in the patient discharge database. Discharge abstract files from OSPHD were obtained after our data request was approved by the Healthcare Information Division of OSHPD, which maintains the data submitted by the hospitals on all inpatient discharges and ED visits, through a secure Internet system. Prehospital records were obtained from the electronic data repository maintained by the prehospital agency serving the two counties.

These data derive from a larger prehospital stroke database that was built to understand the effects of stroke regionalization in these two counties. Therefore, our analysis is limited to these two counties.

Linkage Methodology—To identify patients who were transported by EMS providers and had hospital discharge diagnoses of stroke, we linked the two databases using the variables shown under “Study Variables.” This linkage provided us with patient care records containing prehospital primary impression (acute neurological deficit or other conditions) and hospital discharge diagnosis of stroke. The two databases were linked using probabilistic linkage methodology. The methodology and validation of the methodology have been described elsewhere.[32–35]

Briefly, probabilistic record linkage is accomplished by comparing data fields in two files, such as birthdate or sex. Comparisons of numerous data fields lead to a judgment that two records refer to the same patient and event. By assigning log-likelihood ratios to field comparisons, it is possible to computerize the judgment process. Composite weight for each pair is calculated based on agreement and disagreement weights assigned to available fields for comparison. The composite weight is then translated into probability, which determines that the pair refers to the same person/event. All linkages were conducted in LinkSolv version 8.29746 (Strategic Matching, Inc.).[36]

Study Variables—We performed a one-to-one linkage; thus, an individual electronic prehospital record was permitted to link to, at most, one hospital record, either from the ED discharge or from the patient discharge database. Patients discharged from the ED were in the ED database, while those admitted to the hospital were included in the patient discharge database. Variables used for this linkage were date of incident/admission, hospital code, EMS incident and billing zip code, patient sex, patient race/ethnicity, and age. Hospital admission date was set as up to 1 day following the EMS run date, while the age in the hospital file was required to be within 2 years of the age in the hospital discharge file to receive an agreement weight. All pairs receiving match probabilities of at least 0.80 were considered to be true matches, and all other pairs were rejected as false matches. Because the electronic prehospital database includes nonstroke patients, and the ED discharge and patient discharge databases include non–EMS-transported patients, substantial portions of each database were not expected to link.

Each linked patient record available had the following prehospital and hospital variables for analysis: patient demographics (age, sex, race, ethnicity, insurance status, source of admission), day of admission (weekday/weekend), and hospital characteristics (location by zip code, academic affiliation, stroke center certification status). We kept the race/ethnicity classification provided by OSHPD and, for the prehospital database, study investigators (PG and BG) reviewed the prehospital database and assigned the race/ethnicity documented by prehospital providers to the classification followed by OSHPD. Because patient-level socioeconomic status was not available in the database, patient zip code was used as a proxy for individual socioeconomic status.

Data Analysis

The demographics of the patient population are listed by data source in Table 1. To determine if prehospital stroke recognition differed by race and sex, we calculated the sensitivity and specificity by race and ethnicity (please refer to the Data Supplement S1 [available as supporting information in the online version of this paper] footnotes for definitions of true positive and true negative). The results of the sensitivity and specificity by race and sex are presented in Table 2 and Data Supplement S1e. Additionally, we compared the sensitivity and specificity between non-Hispanic whites, African Americans, Hispanics, and Asians using a logistic regression model. Due to the small number of patients in the other ethnic groups, we did not analyze those groups separately.

We used a priori criteria to support the number of events per covariate included in the model. We used a direct model building strategy. Before modeling the data, we examined frequencies for each of the categorical covariates and a histogram of the age distribution. The only sparse category was Native American race. For Model 1, the Hosmer-Lemeshow goodness-of-fit statistic was not significant ($p = 0.26$), suggesting a good model fit. For Model 2, we assessed the model fit by examining diagnostic plots of dfbetas and high leverage points. We identified only five influential points (which were all Native American) and ran a model dropping these five. The estimates (except for the Native American odds ratio [OR]) remained unchanged.

To study the independent association of race and ethnicity with prehospital stroke sensitivity, we created a model limited to those with hospital-based diagnoses of stroke in the patient discharge databases. The ED database had missing covariates, and also we could not confirm if patients discharged from the ED were in fact true strokes. Therefore, we did not include these records in the analysis. Covariates were chosen based on clinical relevance, data availability, and published research. We controlled for the following covariates in the model: age, sex, payment category, source of admission, and time and day of presentation. In our calculations for specificity, we designed the model to include those without hospital diagnoses of stroke in the ED or patient discharge databases. We were able to control for age, sex, and day of admission in the specificity model. Due to a large number of missing data for source of admission (Table 1) and payment category in the prehospital records, we were not able to control for those covariates in the specificity model. We could not directly adjust for socioeconomic status in the model because the data variable was not available in the databases. However, as a proxy for socioeconomic status, we adjusted for zip code in the sensitivity models. We had a large number of missing zip codes (n = 122,269; 40% of EMS transports) in the prehospital database. Therefore, we ran the specificity model using the available zip code data. We did not see any effect in the point estimates after adjusting for zip code, and therefore, final results are presented without adjustment for zip code. In the prehospital setting, although providers were assigned to specific ambulances, they served different catchment areas within the county and were assigned to the region of highest priority during the service hours, making a systematic difference in recognition by the providers unlikely. Therefore, we performed a sensitivity analysis using generalized estimating equations to account only for hospital clustering within the counties. Additional statistics included chi-square tests to compare proportions. A p-value of ≤ 0.05 was considered statistically significant.

RESULTS

There were 309,866 prehospital transports within the study counties during the 3-year study period. Of those, 3,849 had primary impressions of acute neurological deficits in the prehospital database. The total number of hospitalized patients with primary or secondary hospital diagnoses of stroke in the OSHPD discharge abstract file was 10,719. Of those, 9,212 patients were from the patient discharge database and 1,507 from the ED discharge database. Using probabilistic linkage, we were able to link 3,787 records (35%) of patients who were transported by EMS with documented primary impressions in the electronic database and had hospital discharge diagnoses of stroke in the patient discharge database.

Reliability of the Linkage Algorithm

In an effort to minimize the effects of false true matched pairs on our analysis, we fixed the acceptance probability of a true match at 0.8. Even though the lower bound was 0.8, the majority of matches had probabilities much higher than this. The median match probability was 0.997, with an interquartile range of 0.962 to 0.999. In fact, the 10th percentile match probability was 0.896, indicating that 90% of our matches have a probability of being correct of 0.90 or higher. We used the quantity “1 – match probability” to estimate the false-positive rate for our data set. Doing so gives us a false-positive estimate of 2.9%.

Demographics

The demographic characteristics of the patients included in the study are presented by race and ethnicity (Table 1). Of all EMS transports, the proportion of non-Hispanic whites was 42% (n = 131,152), Hispanics 15% (n = 45,245), Asians 10% (n = 32,396), African

Americans 5% (n = 15,861), and other/Native Americans 1% (n = 148). These are similar to the demographics of our geographic region. When categorized by age, 40% of the study patients were younger than 50 years. We also observed that Hispanic and African American patients with a discharge diagnosis of stroke were younger compared with the other racial and ethnic groups ($p < 0.0001$). Non-Hispanic whites were older (30% were 80+ years of age) while Asians appeared in higher proportions in both the younger (<50) and the older (70 to 79 years and ≥80 years) age categories. Females had a higher proportion of discharge diagnoses of stroke in all racial and ethnic groups except for Hispanics ($p < 0.0001$).

Prehospital Provider Performance Characteristics

Sensitivity and specificity calculations by race are presented in Table 2 and Data Supplement S1. Among 3,787 patients transported by EMS with discharge diagnoses of stroke, 1,223 patients were correctly recognized as having strokes by EMS in the prehospital setting (sensitivity = 32.29%). Only 1% of those not having strokes were incorrectly identified as strokes in the prehospital setting (specificity = 99%). Correct prehospital recognition of stroke was lower in Asians and Hispanics (26.5 and 28.8%, respectively) compared with non-Hispanic whites (35.3%). Correct recognition was lower in females compared to males (30 and 35%, respectively). After controlling for covariates, the regression model adjusted odds ratios (AOR) results show that correct prehospital stroke recognition was lower for Hispanics (AOR = 0.77, 95% confidence interval [CI] = 0.61 to 0.96) and Asians (AOR = 0.66, 95% CI = 0.55 to 0.80), when compared with non-Hispanic whites (Table 3). Correct prehospital recognition that a patient was not experiencing a stroke was lower in Hispanics (AOR = 0.89, 95% CI = 0.79 to 1.01), Asians (AOR = 0.97, 95% CI = 0.87 to 1.08), and African Americans (AOR = 0.99, 95 CI = 0.84 to 1.17), when compared to non-Hispanic whites (Table 4).

Results of the model demonstrated statistically significant differences in prehospital stroke recognition for females when compared to males; that is, correct recognition was lower in females (sensitivity AOR = 0.82, 95% CI = 0.71 to 0.94), and females were also less likely to be correctly identified as not having strokes (specificity AOR = 0.84, 95% CI = 0.78 to 0.90). We did not observe any change to the statistical significance of the results when sensitivity analysis was performed using the generalized estimating equations.

DISCUSSION

Unlike studies that have demonstrated significant differential treatment in the hospital setting, our study reveals a substantial level of disparity in stroke recognition in the prehospital setting. Understanding the presence and relative contributions of disparities at each level of the chain of survival for stroke is important for targeting interventions and eliminating these differences.

Our results indicate that the overall sensitivity for prehospital stroke recognition continues to be low in the study counties. The sensitivity for prehospital stroke recognition and rates of prehospital notification have been shown to vary considerably between regions. Previous studies from the western and southern regions have shown low to moderate sensitivity for stroke recognition by prehospital providers (44 and 61%), whereas more recent studies from

North Carolina show higher sensitivity for stroke recognition in the prehospital setting.[37–41] We believe that differences in prehospital stroke recognition could be multifactorial, e.g., training and education; study methodology, including validity of the linkage algorithm; and data availability for analysis. Studies from regions with lower sensitivity showed a significant improvement following implementation of training programs for prehospital providers.[42,43] We are currently gathering data from qualitative work in these communities to understand the gaps in prehospital training and will design interventions and strategies as part of future work to improve early stroke care.

Significant disparities in the recognition of stroke by prehospital providers exist across racial and ethnic and sex variables. Prehospital providers exhibit significantly decreased sensitivity stroke recognition among minority patients compared to their stroke recognition for non-Hispanic whites. This same pattern of disparity was also seen in female patients compared to males. The magnitude of this disparity is fairly large, particularly in Asian and Hispanic populations.

While we are unaware of other research directly examining the effect of patient race or ethnicity on prehospital stroke recognition, our findings are consistent with those of similar studies in other settings. Review of a nationwide database by Lin et al. [44] revealed that African American stroke patients were less likely to receive prearrival notification than non-Hispanic whites. However, it is unknown to what degree disparities in stroke recognition, a requirement for prearrival notification, are responsible for these finding. Similarly, a study by Kleindorfer et al. [24] found longer EMS transport times for African American stroke patients compared to non-Hispanic whites. Again, it could not be determined whether impaired stroke recognition led to missed diagnoses, subsequently reducing the priority of prehospital transport.

A study by Rathore et al.[45] suggested that the prevalence of specific stroke symptoms may differ between different racial and ethnic groups. However, the prevalence of these differences and its influence on disparities in the prehospital setting remains to be studied in greater detail. Furthermore, racial and ethnic disparities have been documented in stroke risk factors, disease awareness, and symptom self-recognition, but the effect of these factors on prehospital provider diagnostic accuracy is unknown.[22] Diagnostic accuracy can be further strained by cultural and linguistic differences, which have been found to hamper both interpretation and communication of signs and symptoms between patients and providers.[22,46]

The relatively limited education required for EMS certification may also be a contributing factor. Kothari et al.[47] previously identified the minimal formal training of EMS personnel in neurological emergencies as a likely cause of low sensitivity for prehospital stroke recognition. Further, patients presenting in a culturally unfamiliar manner or with atypical symptoms, particularly to a prehospital provider less proficient or less experienced in performing a neurological exam, may be more likely to be misdiagnosed in the prehospital setting.

As with race and ethnicity, widespread sex disparities in stroke care are well documented in other domains and settings.[48] Previous studies have shown sex differences in stroke knowledge, risk factors, presentations, treatment, and postrecovery outcomes.[49] A meta-analysis showed that women have more baseline knowledge of warning signs and risk factors for stroke and after intervention showed better improvement in knowledge than men.[49] A recent study documented that women were able to recognize traditional symptoms of stroke better than males, and report calling 9-1-1 as the action plan when experiencing stroke.[50] However, among stroke survivors, a greater proportion of women delayed seeking care for stroke than males. Studies also show that females are more likely to present with “nontraditional” stroke symptoms, such as fatigue, weakness, disorientation, and mental status change.[48–57]

Our data show that these disparities extend into the prehospital setting. A few recent studies have reported minor sex differences in rates of prearrival notification (1%–4%) but did not explore reasons for these differences.[19,44] Our analysis did not reveal the reasons for sex disparities, but based on existing research, we hypothesize that these could be due to differences in stroke presentations or a combination of provider–patient characteristics.

LIMITATIONS

Our study is limited to two counties in the State of California. However, the training of the prehospital providers, staffing of the ambulances, and EMS configuration (advanced life support response to stroke) are quite similar to the other urban and suburban counties in the State of California, rendering the results more generalizable to other EMS agencies. Further, a recent study in an EMS system in California with a similar structure to our study agencies reported disparities in transport times for acute myocardial infarction.[31] Therefore, it is highly likely that prehospital disparities may be more prevalent in time-sensitive conditions than is known.

As this was a secondary analysis, our data collection was limited by predetermined availability. The ED database did not have source of admission and payment categories, and therefore these were not included in the regression model. We were not able to measure the effect of the patient’s primary language or provider’s race and ethnicity on stroke recognition. However, language is far from a categorical variable. Communication is ultimately dependent on the degree of fluency possessed by both the patient and the provider. Furthermore, language incorporates not only equivalency definitions but also cultural understandings and implications regarding specifics signs, symptoms, and disease processes. As well, in acute conditions like stroke, history is often provided by family members or caregivers; their language proficiency and educational background may influence the outcome. It is therefore likely that adding data on patient language into our regression model alone would fail to accurately predict independent associations.

Another limitation is that we were unable to deterministically match prehospital and hospital diagnoses. However, probabilistic matching is a validated method of matching large databases and has been used in prehospital studies.[58,59] While deterministic linkages are limited by the data quality and the completeness of the databases, probabilistic linkage is a valuable method that overcomes these challenges and is major strength to this study. Our fourth limitation is the missing prearrival notification in the electronic prehospital database, which therefore prevented us from reporting those data, in addition to diagnostic accuracy. Fifth, due to the small number of patients (~3%) who received thrombolytic treatment in our database, we did not study association of race and ethnic disparities on treatment outcomes. However, multiple studies have already demonstrated the impact of accurate EMS stroke recognition and notification on inhospital treatment goals[13–20] and outcomes. Finally, the data are relatively old, and changes may already be occurring in some EMS systems that might mitigate the effects seen in our 2005–2007 data.

CONCLUSIONS

We found racial, ethnic, and sex disparities in the recognition of stroke by prehospital providers. While these findings are consistent with existing research on disparities in stroke prevention efforts and hospital-based stroke care, to our knowledge, this is the first study to report disparities in stroke recognition in the prehospital setting. As more efforts are under way to increase use of emergency medical services in time-sensitive diseases like acute stroke, these disparities may widen and affect patient treatment and outcomes. Therefore, future efforts should aim to understand the contributions of language, prehospital provider characteristics, training, and patient factors to disparities in the prehospital setting. Discerning these factors may lead to restructuring of prehospital training programs, better recognition of stroke, and elimination of disparities in the provision of care in the prehospital setting.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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Table 1

Cohort Demographics, Diagnosis, and Treatment Characteristics

Variable	ED Database (Discharge Diagnosis of Stroke) (*n* = 1,507)	Paramedic Impression of Acute Neurological Deficit/Stroke (*n* = 3,849)	Patient Discharge Database (Hospital Discharge Diagnosis of Stroke) (*n* = 9,212)	Final Matched Sample: EMS-transported Patients Admitted to Hospital and Had a Discharge Diagnosis of Stroke (*n* = 3,787)
Age categories, yr				
<50	164 (10.9)	415 (10.8)	621 (6.7)	238 (6.3)
50–59	207 (13.7)	454 (11.8)	844 (9.2)	392 (10.4)
60–69	225 (14.9)	535(14)	1,240 (13.5)	493 (13)
70–79	364 (24.2)	951 (25)	2,396 (26.0)	937 (24.7)
≥80	547 (36.3)	1,420 (37)	4,111 (44.6)	1,727 (45.6)
Missing	—	74 (2)	—	—
Sex				
Male	696 (46.2)	1,763 (45.8)	4,264 (46.3)	1,694 (44.7)
Female	811 (53.8)	2,058 (53.5)	4,948 (53.7)	2,093 (55.3)
Missing	—	28 (0.7)	—	
Race/ethnicity				
Non-Hispanic white	837 (55.5)	2,003 (52)	5,587 (60.6)	2,272 (60)
African American	73 (4.8)	155 (4)	398 (4.3)	140 (3.7)
Asian	183 (12.1)	392 (10)	1,680 (18.2)	712 (18.8)
Hispanic	267 (17.7)	342 (9)	1,185 (12.9)	507 (13.4)
Native American	—	3 (0.1)	7 (0.1)	2 (0.1)
Missing	147 (9.8)	954 (25)	355 (3.9)	154 (4.1)
Source of admission				
Home	—	—	7,839 (85.1)	3,471 (91.7)
Residential care	—	—	395 (4.3)	133 (3.5)
Ambulatory surgery	—	—	7 (0.1)	3 (0.1)
Skilled nursing	—	—	871 (9.5)	145 (3.8)
Acute inpatient hospitalization	—	—	21 (0.2)	8 (0.2)
Other inpatient hospitalization	—	—	10 (0.1)	4 (0.1)
Prison	—	—	17 (0.2)	4 (0.1)
Other	—	—	52 (0.6)	19 (0.5)
Missing	1,507 (100.0)	—	—	—
Payment category				
Medicare	—	—	6,944 (75.4)	2,737 (72.3)
MediCAL	—	—	769 (8.3)	277 (7.3)
Private	—	—	1,171 (12.7)	581 (15.3)
Indigent	—	—	88 (1.0)	49 (1.3)
Self -pay	—	—	204 (2.2)	126 (3.3)
Other/Unknown	—	—	32 (0.3)	16 (0.4)
Missing	1,507 (100.0)	—	4 (0.0)	—

Variable	ED Database (Discharge Diagnosis of Stroke) (*n* = 1,507)	Paramedic Impression of Acute Neurological Deficit/Stroke (*n* = 3,849)	Patient Discharge Database (Hospital Discharge Diagnosis of Stroke) (*n* = 9,212)	Final Matched Sample: EMS-transported Patients Admitted to Hospital and Had a Discharge Diagnosis of Stroke (*n* = 3,787)
Day of the week				
Weekday	1,147 (76.1)	2,774 (72.1)	6,611 (71.8)	2,742 (72.4)
Weekend	360 (23.9)	1,075 (27.9)	2,601 (28.2)	1,045 (27.6)
Prehospital provider impression of acute neurological deficit				
No	1,254 (83.2)	—	7,823 (84.9)	2,564 (67.7)
Yes	253 (16.8)	3,849 (100)	1,389 (15.1)	1,223 (32.3)
Missing	—	—	—	
Hospital diagnosis of stroke				
Primary diagnosis	758 (50.3)	—	3,787 (41.1)	3,787 (100.0)
Secondary diagnosis	749 (49.7)	—	5,425 (58.9)	—
IV t-PA use				
No	—	—	9,004 (97.7)	3,637 (96.0)
Yes	—	—	208 (2.3)	150 (4.0)
Missing	1,507 (100.0)	—	—	—

Data are reported as *n* (%)

— = 0 value for the field; t-PA = tissue plasminogen activator.

Table 2

Performance Characteristics of Prehospital Providers for Stroke Recognition by Race/Ethnicity

					Sex	
Performance Characteristic	**Non-Hispanic White (*n* = 131,152)**	**Hispanic (*n* = 45,245)**	**African American (*n* = 15,861)**	**Asian (*n* = 32,396)**	**Male**	**Female**
Sensitivity	35.3 (33–37)	28.8 (25–33)	30 (22.4–37.6)	26.5 (23–30)	35 (32–37)	30 (28–32)
Specificity	98.4 (98.3–98.4)	99.2 (99.1–99.3)	99 (98.8–99.1)	98.7 (98.5–99)	98.7 (98.7–98.8)	98.6 (98.6–98.7)
PPV	27.5 (26–29)	29 (25–33)	20.8 (15.1–26.4)	31 (27–35)	24 (23–26)	23 (21–24)
NPV	98.9 (98–99)	99 (99.1–99.3)	98.4 (98.2–98.6)	98.3 (98.2–98.5)	99 (99.2–99.3)	99.1 (99–99.1)

Data are reported as rate (95% CI). For raw data and 2 × 2 tables on sensitivity and specificity data, please refer to Data Supplement S1.

NPV = negative predictive value; PPV = positive predictive value

Table 3

Predictors of Identifying Stroke Presentations in the Prehospital Setting Among Those With a Final Hospital-based Diagnosis of Stroke (n = 3,786)

Variable	Adjusted OR (95% CI)	p-value
Age	1.004 (0.997–1.01)	0.26
Sex		
Male	Referent	
Female	0.82 (0.71–0.94)	0.005
Race/ethnicity		
Non-Hispanic white	Referent	
Hispanic	0.77 (0.61–0.96)	0.019
Asian	0.66 (0.55–0.80)	<0.0001
Other*	0.71 (0.53–0.94)	0.019
Unknown	1.18 (0.58–2.40)	0.65
Source of admission		
Home	Referent	
Residential care	0.67 (0.45–0.99)	0.048
Ambulatory surgery	1.10 (0.099–12.3)	0.94
Skilled nursing	0.80 (0.55–1.16)	0.25
Acute inpatient hospital	3.4 (0.80–14.30)	0.097
Other inpatient hospital	0.71 (0.07–6.90)	0.77
Prison	1.05 (0.10–10.90)	0.97
Other	0.36 (0.11–1.26)	0.11
Payment category		
Medicare	Referent	
Medical	0.86 (0.63–1.19)	0.38
Private	1.15 (0.91–1.47)	0.25
Indigent	0.55 (0.25–1.19)	0.13
Self-pay	1.38 (0.93–2.00)	0.11
Other/unknown	0.53 (0.15–1.91)	0.33
Primary stroke center		
No	Referent	
Yes	1.09 (0.91–1.30)	0.35
Hospital type		
Community	Referent	
Academic	0.86 (0.58–1.29)	0.47
Day of the week		
Weekday	Referent	
Weekend	1.02 (0.87–1.19)	0.84

*African Americans were analyzed as a group and we did not find any statistical significance; OR = 0.85 (95% CI = 0.58 to 1.2)

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Table 4

Predictors of Identifying a Nonstroke Presentations in the Prehospital Setting Among Those Without a Final Hospital-based Diagnosis of Stroke (*n* = 214,643)

Variable	**Adjusted OR (95% CI)**	**p-value**
Age	1.03 (1.03–1.04)	<0.0001
Sex		
Male	Referent	
Female	0.84 (0.78–0.90)	<0.0001
Race/ethnicity		
Non-Hispanic white	Referent	
African American	0.99 (0.84–1.17)	0.89
Asian	0.97 (0.87–1.08)	0.60
Hispanic	0.89 (0.79–1.01)	0.062
Native American	2.2 (0.71–7.1)	0.17
Day of the week		
Weekday	Referent	
Weekend	1.05 (0.96–1.13)	0.29