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Association between Patient Race and Staff Resuscitation Efforts After Cardiac Arrest in Outpatient Dialysis Clinics: a study from the CARES Surveillance Group

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Abstract

Background: Cardiac arrest is the leading cause of death among patients receiving hemodialysis. Despite guidelines recommending CPR training and AED presence in dialysis clinics, rates of CPR and AED use by dialysis staff are suboptimal. Given that racial disparities exist in bystander CPR administration in non-healthcare settings, we examined the relationship between patient race/ethnicity and staff-initiated CPR and AED application within dialysis clinics.

Methods: We analyzed data prospectively collected in the Cardiac Arrest Registry to Enhance Survival across the U.S. from 2013-2017 and the Centers for Medicare & Medicaid Services dialysis facility database to identify outpatient dialysis clinic cardiac arrest events. Using

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multivariable logistic regression models, we examined relationships between patient race/ethnicity and dialysis staff-initiated CPR and AED application.

Results: We identified 1,568 cardiac arrests occurring in 809 hemodialysis clinics. The racial/ethnic composition of patients was 31.3% white, 32.9% black, 10.7% Hispanic/Latinx, 2.7% Asian, and 22.5% other/unknown. Overall, 88.0% of patients received CPR initiated by dialysis staff, but rates differed by race: 91% of white patients, 85% of black patients, and 77% of Asian patients ($p=0.005$). After adjusting for differences in patient and clinic characteristics, black ($OR=0.41$, 95% CI 0.25-0.68) and Asian patients ($OR=0.28$, 95% CI 0.12-0.65) were significantly less likely than white patients to receive staff-initiated CPR. No significant difference between staff-initiated CPR rates among white, Hispanic/Latinx, and other/unknown patients was observed. An AED was applied by dialysis staff in 62% of patients. In adjusted models, there was no relationship between patient race/ethnicity and staff AED application.

Conclusions: Black and Asian patients are significantly less likely than white patients to receive CPR from dialysis staff. Further understanding of practices in dialysis clinics and increased awareness of this disparity are necessary to improve resuscitation practices.

Keywords

hemodialysis; cardiovascular events; dialysis complications; cardiac arrest; cardiopulmonary resuscitation; racial disparity

Introduction:

Over 725,000 people in the U.S. have end-stage renal disease (ESRD) and more than 450,000 require maintenance hemodialysis. Hemodialysis patients experience sudden cardiac arrest at rates more than 20 times greater than in the general population.¹⁻³ Out-of-hospital cardiac arrest (OHCA) occurs most frequently on hemodialysis days and often occurs within outpatient dialysis clinics; an average-sized dialysis clinic experiences approximately one in-clinic cardiac arrest per year.⁴⁻⁶ Outcomes following dialysis clinic OHCA are poor, with 56% survival to hospital admission, 24% survival to hospital discharge, and 8% one-year survival.⁶

Early provision of cardiopulmonary resuscitation (CPR) and rapid defibrillation by bystanders significantly increase the chance of OHCA survival.^{7,8} A recent study of OHCA occurring in 158 U.S. outpatient hemodialysis clinics found that CPR initiated by dialysis staff was associated with a three-fold higher odds of survival; however, the study also found that dialysis staff did not initiate CPR in nearly 1 out of every 5 cases and did not apply a defibrillator in almost half of cases.⁹

Racial and ethnic minorities are less likely than white individuals to receive bystander CPR in non-healthcare settings.¹⁰⁻¹⁵ Additionally, rates of bystander CPR vary according to neighborhood characteristics, with lower rates within low-income, black-predominant neighborhoods.¹⁶⁻²¹ Within the hemodialysis population, racial disparities are well documented; compared with white patients, racial and ethnic minorities have a higher risk of developing ESRD¹ and are less likely to receive optimal treatments for ESRD, including the use of arteriovenous fistulas²² and kidney transplantation.^{23,24}

In this study, we examined whether patient race/ethnicity is associated with resuscitation efforts within outpatient dialysis clinics. We hypothesized that black and Hispanic/Latinx patients would be less likely than white patients to receive bystander CPR and AED application from dialysis staff. Secondly, we sought to examine the association between dialysis clinic characteristics, including clinic neighborhood characteristics, and the likelihood of staff-initiated CPR and AED application.

Methods:

Data Source and Study Design

All patient-level, resuscitation, and outcome data were obtained from the Cardiac Arrest Registry to Enhance Survival (CARES), a nationwide prospective clinical registry of OHCA in the United States. Coordinated by the Centers for Disease Control and Emory University, CARES was created to collect data on resuscitation practices and outcomes to inform quality improvement efforts. The registry has been described in detail elsewhere.^{25,26} CARES includes confirmed OHCA (defined as apneic and unresponsive) events where resuscitation is attempted. Patients with a do-not-resuscitate order are excluded from the CARES registry by protocol. When an OHCA occurs, data are collected from 911 dispatch centers, EMS agencies, and receiving hospitals by a dedicated analyst. Location information is catalogued with an exact street address and a location type. CPR initiation and AED application, including who completed each, are documented for each cardiac arrest. Uniformity is ensured via standardized Utstein definitions for clinical variables and OHCA outcomes.²⁷ For this study, we analyzed OHCA events between 2013 and 2017 within the registry catchment area (Supplemental Figure 1).

To obtain information on dialysis clinic locations and clinic-level variables, we used the Centers for Medicare and Medicaid Services' Dialysis Facility Compare dataset, a resource designed to track quality and outcome data for all Medicare-funded dialysis clinics.²⁸ This dataset includes information on location, operation dates, ownership, number of dialysis stations, and the "star" rating (a composite quality metric based on mortality and hospitalization ratios, patient laboratory values, and other measures of optimal dialysis care) for each clinic. To investigate the role of neighborhood characteristics, we obtained information on median household income, proportion of residents with self-reported black race, and population density of the neighborhood surrounding each clinic from the 2016 American Community Survey 5-year estimates and 2010 U.S. Census Summary Files. Census tracts were used as proxies for neighborhoods, as they represent economically and socially homogeneous groups of approximately 1,200 to 8,000 residents.²⁹ Census data also served as surrogate measures of overall dialysis clinic patient racial composition and socioeconomic status. We excluded dialysis clinics that did not offer in-center hemodialysis, were attached to hospitals, were not in operation during the study period, or had addresses in zip codes not covered by CARES.

Identification of Dialysis Clinic Events and Selection of Study Cohort

We excluded patients <18 years old, events at locations categorized as private residences, roadways, or nursing homes, and events with missing/incomplete address information. Since

dialysis clinics are not specifically denoted within CARES, we used a method to identify outpatient hemodialysis clinics that has previously been cross-validated with dialysis clinic records with confirmation of >95% of examined events within CARES.⁹ We geocoded outpatient hemodialysis clinic addresses in the Dialysis Facility Compare dataset and used ArcGIS Pro (ESRI, Redlands, CA) to match locations with geocoded OHCA events in CARES. We manually reviewed the addresses of all events occurring within a 200-meter radius of an outpatient dialysis clinic, excluding events at non-matching addresses. Since our study focused on the resuscitation efforts that occurred prior to the arrival of emergency response teams, we excluded OHCA events that were reported as being witnessed on-site by 911 responders. Finally, since dialysis staff performance of CPR and AED application were the primary outcomes for our study, we included only events that identified the initiator of resuscitation procedures (CPR or AED application) as either being “lay person medical provider” (referred to hereafter as “dialysis staff” or “staff”) or “EMS/First responder” (used as the comparison group). CARES defines a “lay person medical provider” as any health care provider who is not a part of the organized rescue team.

Independent Variables and Outcome Measures

Patient-level variables from CARES included age, sex, and race/ethnicity. CARES allows emergency responders to input a single race/ethnicity categorization for each OHCA patient (options include American Indian/Alaska Native, Asian, Black/African-American, Hispanic/Latinx, Native-Hawaiian/Pacific-Islander, White, and Unknown). Clinic-level variables included ownership, number of dialysis stations, star rating, standardized mortality ratio, neighborhood characteristics (proportion black race, median household income, and population density), and U.S. geographic region (defined by the U.S. Census Bureau; Supplemental Figure 2).

The primary outcome measure was the initiation of CPR and AED application by dialysis staff. Secondary outcome measures included patient survival to hospital discharge and favorable neurologic status upon discharge, defined as cerebral performance category 1 or 2, with 1 representing full recovery or mild disability and 2, moderate disability but independent in activities of daily living.³⁰

Statistical Analysis

In order to explore differences in resuscitation practices according to patient race/ethnicity and dialysis clinic characteristics, we compared the characteristics of OHCA events where dialysis staff initiated CPR or applied an AED with those where no resuscitation was initiated until emergency responders arrived on scene. Group differences were assessed with Pearson chi-square tests for categorical variables and Wilcoxon rank-sum tests for continuous variables.

To examine independent associations between patient race/ethnicity, clinic characteristics, and staff-initiated CPR and AED application, we used logistic regression models that included patient-level variables (model 1) and subsequently added clinic-level variables (model 2) to examine their contributions. To account for the nesting of 1,568 patients (level 1) within 809 dialysis clinics (level 2), we used two-level hierarchical logistic regression

models. Multivariable adjusted odds ratios (aORs) and 95% confidence intervals (95% CIs) were estimated from the multilevel models with a *P* value of 0.05 considered statistically significant. We performed interaction testing to identify potential differences in association between patient race or ethnicity and the primary outcomes according to other patient (age and sex) and clinic-level characteristics (clinic ownership, size, star rating, standardized mortality ratio, neighborhood characteristics [proportion black race, median household income, and population density], and U.S. geographic region).

As an additional sensitivity analysis to address unmeasured clinic-level confounding underlying associations between patient race and staff-initiated CPR, we examined events within dialysis clinics that had at least one black and one white patient experience OHCA. Kruskal-Wallis tests were used to compare the rate of staff-initiated CPR between black and white patients in these clinics.

Finally, we examined the association between staff-initiated CPR and AED placement and survival outcomes using logistic regression models adjusted for patient characteristics. We included interactions to identify any potential differences in survival benefit of staff-initiated CPR or AED placement by patient race/ethnicity.

All analyses were performed using Stata v15.0 (StataCorp). The study was approved by the Duke University Institutional Review Board (Pro00100893).

Results:

Figure 1 illustrates the identification of dialysis clinic events within CARES. The study cohort included 1,568 OHCA events occurring within 809 unique dialysis clinics. The mean age of patients was 65.6 years; 57.4% were male. Reported race/ethnicity was 31.3% white, 32.9% black, 10.7% Hispanic/Latinx, 2.7% Asian, and 22.5% other/unknown.

Table 1 compares the characteristics of patients who received initial resuscitation efforts from dialysis staff with those who did not. Dialysis staff initiated CPR in 88% of events and applied an AED prior to the arrival of 911 responders in 62% of events. Among white patients, 91% received staff-initiated CPR, compared to 89% of Hispanic/Latinx patients ($p=0.54$), 85% of black patients ($p=0.004$), and 77% of Asian patients ($p=0.006$). Staff AED application occurred in 66% of white patients, compared to 60% of black patients ($p=0.07$), 58% of Hispanic/Latinx patients ($p=0.08$), and 49% of Asian patients ($p=0.04$). There were no significant differences in dialysis clinic quality measures between patients who did or did not receive staff CPR and AED application. Staff CPR and AED application were less likely in clinics located in neighborhoods with high population density. Patients who received staff CPR and staff AED application were significantly more likely to survive to hospital discharge and have a favorable neurologic status upon discharge.

Table 2 examines the multivariable adjusted associations between patient and clinic-level characteristics and CPR initiation by dialysis staff. In a model adjusted for patient-level factors and in a model fully adjusted for both patient and clinic-level factors, black and Asian patients were significantly less likely than white patients to receive CPR initiated by dialysis staff (fully adjusted model, black vs. white OR=0.41, 95%CI 0.25-0.68; Asian vs.

white OR=0.28, 95%CI 0.12-0.65). Hispanic/Latinx ethnicity was not associated with CPR initiated by dialysis staff. No clinic-level characteristics demonstrated significant association with staff CPR.

Table 3 describes the association between patient race/ethnicity and staff AED application. After adjusting for patient-level characteristics, Asian patients were less likely than white patients to have an AED applied by dialysis staff, but the association did not persist after adjusting for clinic-level factors. There were no other associations observed between patient race/ethnicity and staff AED application. There was a significant inverse relationship between clinic neighborhood population density and staff AED application (OR=0.86, 95%CI 0.77-0.95), and a greater likelihood of staff AED application within dialysis clinics in the US Northeast (OR=1.83 95%CI 1.22-2.75).

Interactions were tested to explore whether the association between patient race/ethnicity and staff-initiated CPR varied according to other patient and clinic characteristics. A significant interaction was noted between patient race/ethnicity and U.S. region (interaction $p=0.01$). Black race was associated with a decreased likelihood of CPR initiation by dialysis staff in the U.S. South and West, whereas no significant associations were observed in the Northeast and Midwest (Figure 2). An interaction between patient race/ethnicity and age was also noted, with older black patients less likely than younger black patients to receive staff-initiated CPR (interaction $p=0.02$).

To further address potential confounding related to unmeasured dialysis clinic factors, we performed a sensitivity analysis to explore potential racial disparities in receipt of staff CPR in clinics where both black and white patients experienced OHCA. We identified 73 clinics where at least one white and at least one black patient experienced cardiac arrest during the study period, involving 246 cardiac arrest events. Within these clinics, the rate of staff-initiated CPR was significantly lower for black patients (85%, N=135) compared with white patients (92%, N=111; $p=0.004$), consistent with the overall study findings.

Finally, we examined the association between staff-initiated CPR and AED placement and survival outcomes, overall and by patient race (Supplemental Tables 1 and 2 respectively). After adjusting for patient characteristics, staff-initiated CPR was associated with improved survival to hospital discharge (OR=1.58, 95%CI 1.05-2.38) and favorable neurologic status on hospital discharge (OR=1.62, 95%CI 1.03-2.54). Staff AED placement associated with a nonsignificant trend towards improved survival to hospital discharge (OR=1.27, 95%CI 0.98-1.63) and favorable neurologic status (OR=1.32, 95%CI 1.00-1.73). Subgroup analyses by race indicated that there were no significant interactions between staff CPR, patient race, and the outcomes of survival to hospital discharge and favorable neurologic status (all interaction p -values >0.25), indicating that the benefits associated with staff CPR were consistent across all racial groups.

Discussion:

In this study of OHCA in outpatient dialysis clinics, we found that dialysis staff were less likely to perform CPR prior to EMS arrival for black and Asian patients compared with

white patients. This disparity persisted after adjusting for patient age and sex, dialysis clinic characteristics, and clinic neighborhood characteristics. Similar findings of racial disparities in bystander resuscitation efforts have been reported in cases of community OHCA,^{10,12,31} but to our knowledge, our study is the first to document them in any non-hospital healthcare setting. Racial disparities in bystander CPR occurring in homes and public locations have been attributed to decreased likelihood of bystander CPR training within communities where racial and ethnic minorities are more likely to experience OHCA.^{32,33} In contrast, lack of training cannot explain racial disparities in bystander CPR within dialysis clinics, as dialysis staff are required to be certified in CPR and AED use.³⁴

Clinic-level factors could explain racial disparities in dialysis staff CPR. For example, dialysis clinics which provide lower quality care including lower bystander CPR rates may have higher enrollment of black and Asian patients. While this has helped to explain racial disparities in health care delivery in other settings,³⁵ accounting for clinic quality measures did not attenuate the association between patient race and staff CPR in our study. Additionally, the association persisted even after restricting the analysis to only clinics where both black and white patients experienced OHCA, further minimizing the possibility of confounding due to clinic-level factors. Nevertheless, it is possible that the racial disparity could be explained by other unmeasured clinic level variables such as staff/patient racial concordance, staff:patient ratios, and experience level of staff.

The racial disparity in staff CPR could be related to other unmeasured patient-level factors. Although though patients with do-not-resuscitate orders were excluded in our study, dialysis staff may have been reluctant to perform CPR for patients with higher burdens of comorbidity, which may have differed by patient race. As patient medical history is an optional field in CARES, we had insufficient data on comorbidity to examine the associations with staff CPR. Uncertainty about patients' advanced directives may also have led to delays in CPR. Black patients are less likely to have advanced directives in place, more likely to express discomfort discussing death, and more likely to desire aggressive care at the end of life compared to white patients.^{36,37} Even if these underlying factors explain the observed racial disparity, it still represents a significant, racially-disparate deficiency in care, as dialysis staff should always perform resuscitation in accordance with patients' wishes.

Since the racial disparity persisted after utilizing multiple methods to control for confounding, it is possible that implicit biases held by dialysis clinic staff played a role. Implicit bias, or unconsciously held associations about a group which result in treatment differences that should otherwise be equal, is well documented among healthcare professionals^{38,39} and has been associated with racial disparities in treatment decisions.^{40,41} The impact of implicit bias is exacerbated in situations where health care providers face time pressure, stress, and uncertainty due to complex medical problems – factors that are heightened during a peri-dialytic OHCA.^{42,43} Demonstrating the influence of implicit bias is difficult, but our findings emphasize the critical importance of improving all aspects of the resuscitation response in dialysis clinics to ensure that all patients, regardless of race, receive high quality resuscitation efforts.

In contrast to a previous study that demonstrated that low-income, black-predominant neighborhoods had lower rates of bystander CPR,²¹ we did not find a significant association between either neighborhood racial composition or median household income and resuscitation efforts by dialysis staff. Thus, targeting dialysis clinics within at-risk communities for resuscitation training interventions, a strategy that has been proposed to improve bystander CPR rates,³² may not be an effective strategy to improve resuscitation efforts in dialysis clinics. Observed regional differences in dialysis staff CPR are consistent with previous findings in non-dialysis settings,⁴⁴ and the localization of more prominent racial disparities in the U.S. South and West should be further investigated.

Contrary to our hypothesis and previous literature,¹⁴ our study did not find any associations between Hispanic/Latinx ethnicity and CPR initiation or AED application by dialysis staff. A possible explanation is that CARES does not report Hispanic/Latinx ethnicity separate from race, resulting in the misclassification of white and black Hispanic/Latinx patients as either white or black. While healthcare disparities among Asians have been previously documented,^{45,46} our finding of racial disparities among Asian patients was also unexpected; such disparities in CPR and dialysis care have not been previously described.

Several important limitations should be considered. First, 20.7% of our study population had race/ethnicity coded as “unknown.” This subgroup did not differ significantly from white patients in rates of staff-initiated CPR and AED application, so it is unlikely that more complete coding of race/ethnicity would have changed our findings. Second, patient race/ethnicity in CARES was determined by emergency responders and was not self-identified. That being said, the use of outside observer-assigned race has been proposed as an important method to understand racial disparities, particularly within healthcare.^{47,48} Third, we did not have data on other patient, clinic, and staff factors that may have affected the delivery of CPR or AED application. Fourth, even though CARES has a catchment of over 115 million people, it is derived largely from urban communities and our results may not be generalizable to other areas of the U.S. Finally, although misclassification of dialysis clinic cardiac arrest events could have occurred, we applied multiple levels of location validation and previously validated a subset of events with dialysis clinic records.

In conclusion, black and Asian patients who experienced OHCA in dialysis clinics were less likely than white patients to receive CPR initiated by dialysis staff. Research focused on interventions such as increased patient monitoring to improve cardiac arrest recognition, improved quality of dialysis-specific CPR training and protocols, and implementation of implicit bias training may help reduce racial disparities and improve overall care. Greater accountability for dialysis staff-initiated CPR rates, either within dialysis organizations or on a national level, may also improve disparities, as has been observed for other health outcome disparities in hemodialysis patients.⁴⁹ Further research into these interventions may not only address the observed racial disparities, but may also improve the overall quality of resuscitation and survival outcomes in this high-risk population.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Figure 1: Identification of the Outpatient Dialysis Clinic Cardiac Arrest Cohort

Figure 2: Association of Patient Race with Staff Initiated CPR by Region

Boxes represent point estimates and horizontal lines represent 95% confidence intervals.

Models adjusted for patient age, sex, and cardiac arrest witnessed status.

*White race used as reference group for all comparisons.

**Stratification by region for Asian patients not performed due to sample size

Table 1:

Characteristics of Dialysis Unit Cardiac Arrests According to Whether Dialysis Staff Initiated CPR and Applied an AED

	CPR Not Initiated by Dialysis Staff	CPR Initiated by Dialysis Staff	AED Not Applied by Dialysis Staff	AED Applied by Dialysis Staff
Characteristic	N=187 (11.9%)	N=1381 (88.1%)	N=598 (38.1%)	N=970 (61.9%)
Patient-Level Characteristics				
Age (Mean [SD])	66.2 (13.0)	65.3 (12.5)	65.9 (13.0)	65.2 (12.3)
Female Sex	87/186 (46.8%)	580/1381 (42.0%)	261/597 (43.7%)	406/970 (41.9%)
Race				
White	43/186 (23%) *	447/1381 (32.4%) *	167/597 (28.0%) *	323/970 (33.3%) *
Black	77/186 (41.2%) **	438/1381 (31.7%) *	205/597 (34.3%)	310/970 (32.0%)
Hispanic/Latinx	18/186 (9.6%)	149/1381 (10.8%)	70/597 (11.7%)	97/970 (10.0%)
Asian	10/186 (5.3%) *	33/1381 (2.4%) *	22/597 (3.7%)	21/970 (2.2%)
Other/Unknown	38/186 (20.3%)	314/1381 (22.7%)	133/597 (22.3%)	219/970 (22.6%)
Witnessed Arrest	142/187 (76%) *	1190/1381 (86%) *	497/598 (83.1%)	835/970 (86.1%)
Dialysis Clinic Characteristics				
Dialysis Ownership				
Non-Profit Non-Chain	6/186 (3.2%) *	13/1378 (0.9%) *	8/597 (1.3%)	11/967 (1.1%)
Non-Profit Chain	18/186 (9.7%)	139/1378 (10.1%)	64/597 (10.7%)	93/967 (9.6%)
Profit Non-Chain	3/186 (1.6%)	34/1378 (2.5%)	14/597 (2.3%)	23/967 (2.4%)
Profit Chain	159/186 (85.5%)	1192/1378 (86.5%)	511/597 (85.6%)	840/967 (86.9%)
Dialysis Facility Compare Star Rating				
Low (1 to 2)	13/177 (7.3%)	88/1289 (6.8%)	44/555 (7.9%)	57/911 (6.3%)
Medium (3)	69/177 (39%)	489/1289 (37.9%)	199/555 (35.9%)	359/911 (39.4%)
High (4 to 5)	95/177 (53.7%)	712/1289 (55.2%)	312/555 (56.2%)	495/911 (54.3%)
Clinic Standardized Mortality Ratio (mean [SD])	21.5 (5.1)	21.7 (4.8)	21.6 (4.8)	21.7 (4.8)
U.S. Region				
Northeast	25/187 (13.4%)	154/1381 (11.2%)	53/598 (8.9%) *	126/970 (13.0%) *
Midwest	36/187 (19.3%)	279/1381 (20.2%)	117/598 (19.6%)	198/970 (20.4%)
South	72/187 (38.5%)	543/1381 (39.3%)	255/598 (42.6%) *	360/970 (37.1%) *
West	54/187 (28.9%)	405/1381 (29.3%)	173/598 (28.9%)	286/970 (29.5%)
Number of Dialysis Chairs (mean [SD])	22.2 (9.2)	23.3 (9.8)	22.7 (9.0)	23.4 (10.2)
Dialysis Clinic Neighborhood Characteristics				
Proportion Black (Tertiles)				
Low	63/187 (33.7%)	467/1378 (33.9%)	192/598 (32.1%)	338/967 (35.0%)
Medium	66/187 (35.3%)	459/1378 (33.3%)	213/598 (35.6%)	312/967 (32.3%)
High	58/187 (31.0%)	452/1378 (32.8%)	193/598 (32.3%)	317/967 (32.8%)
Median Household Income (Tertiles)				

	CPR Not Initiated by Dialysis Staff	CPR Initiated by Dialysis Staff	AED Not Applied by Dialysis Staff	AED Applied by Dialysis Staff
Characteristic	N=187 (11.9%)	N=1381 (88.1%)	N=598 (38.1%)	N=970 (61.9%)
Low	58/186 (31.2%)	461/1378 (33.5%)	201/597 (33.7%)	318/967 (32.9%)
Medium	53/186 (28.5%)	465/1378 (33.7%)	194/597 (32.5%)	324/967 (33.5%)
High	75/186 (40.3%)	452/1378 (32.8%)	202/597 (33.8%)	325/967 (33.6%)
Area Population Density (Tertiles)				
Low	51/187 (27.3%)	476/1381 (34.5%)	185/598 (30.9%)	342/970 (35.3%)
Medium	58/187 (31.0%)	459/1381 (33.2%)	185/598 (30.9%)	332/970 (34.2%)
High	78/187 (41.7%) *	446/1381 (32.3%) *	228/598 (38.1%) *	296/970 (30.5%) *
Patient Outcomes				
Survival to Hospital Discharge	34/187 (18.2%) *	356/1376 (25.9%) *	132/596 (22.1%) *	258/967 (26.7%) *
Favorable Neurologic Status at Discharge **	28/187 (15.0%) *	303/1376 (22.0%) *	109/596 (18.3%) *	222/967 (23.0%) *

* Indicates statistical significant group difference (p < 0.05)

** Defined as cerebral performance category 1 or 2, with 1 representing full recovery or mild disability and 2, moderate disability but independent in activities of daily living.³⁰

Table 2:

Adjusted Multivariable Models for CPR Initiation by Dialysis Staff

Variable	Model Adjusted Only for Patient-Level Characteristics		Model Adjusted for Patient and Clinic-Level Characteristics	
	OR (95% CI)	P Value	OR (95% CI)	P Value
Patient-level Characteristics				
Race/Ethnicity				
White	1 (reference)		1 (reference)	
Black	0.50 (0.32-0.78)	0.003	0.41 (0.25-0.68)	0.001
Asian	0.25 (0.11-0.59)	0.002	0.28 (0.12-0.65)	0.001
Hispanic/Latinx	0.72 (0.38-1.36)	0.31	0.70 (0.36-1.34)	0.28
Other/Unknown	0.71 (0.43-1.17)	0.18	0.80 (0.47-1.34)	0.39
Age (per year increase)	0.99 (0.98-1.01)	0.30	0.99 (0.98-1.01)	0.44
Sex				
Female	1 (reference)		1 (reference)	
Male	1.29 (0.92-1.82)	0.14	1.30 (0.93-1.83)	0.13
Witnessed arrest (ref: unwitnessed arrest)	1.96 (1.30-2.98)	0.001	1.99 (1.32-3.00)	0.001
Dialysis Clinic Characteristics				
Facility Type				
For profit chain-based clinic			1.15 (0.70-1.91)	0.58
Other (non-profit, non-chain)			1 (reference)	
Number of dialysis chairs (per 1 chair increase)			1.02 (1.00-1.04)	0.08
Dialysis Facility Compare Star Rating				
Low			1.02 (0.50-2.11)	0.95
Medium			0.92 (0.63-1.36)	0.69
High			1 (reference)	
Clinic Standardized Mortality Ratio			1.01 (0.97-1.05)	0.76
U.S. Region				
South			1 (reference)	
Northeast			0.72 (0.40-1.30)	0.28
Midwest			1.07 (0.65-1.77)	0.80
West			0.93 (0.55-1.56)	0.77
Neighborhood population density (log transformed)			0.86 (0.73-1.01)	0.08
Neighborhood proportion black			1.49 (0.66-3.36)	0.34
Neighborhood median household income (per \$10,000 increase)			0.93 (0.87-1.00)	0.07

Table 3:

Adjusted Multivariable Models for AED Application by Dialysis Staff

Variable	Model Adjusted for Patient-Level Characteristics		Model Adjusted for Patient and Clinic-Level Characteristics	
	OR (95% CI)	P Value	OR (95% CI)	P Value
Patient-level Characteristics				
Race/Ethnicity				
White	1 (reference)		1 (reference)	
Black	0.82 (0.62-1.09)	0.17	0.98 (0.71-1.34)	0.89
Asian	0.49 (0.25-0.95)	0.04	0.58 (0.30-1.11)	0.10
Hispanic/Latinx	0.69 (0.46-1.02)	0.07	0.79 (0.53-1.18)	0.26
Other/Unknown	0.84 (0.62-1.14)	0.27	0.88 (0.64-1.21)	0.423
Age (per year increase)	1.00 (0.99-1.00)	0.30	1.00 (0.99-1.00)	0.32
Sex				
Female	1 (reference)		1 (reference)	
Male	1.12 (0.89-1.40)	0.33	1.10 (0.88-1.37)	0.41
Witnessed arrest (ref: unwitnessed arrest)	1.32 (0.97-1.79)	0.07	1.29 (0.96-1.74)	0.09
Dialysis Clinic Characteristics				
Facility Type				
For profit chain-based clinic			1.10 (0.80-1.52)	0.56
Other (non-profit, non-chain)			1 (reference)	
Number of dialysis chairs (per 1 chair increase)			1.01 (1.00-1.02)	0.11
Dialysis Facility Compare Star Rating				
Low			0.99 (0.63-1.58)	0.98
Medium			1.16 (0.91-1.48)	0.23
High			1 (reference)	
Clinic Standardized Mortality Ratio			1.01 (0.98-1.03)	0.69
U.S. Region				
South			1 (reference)	
Northeast			1.83 (1.22-2.75)	0.003
Midwest			1.34 (0.98-1.84)	0.07
West			1.31 (0.94-1.82)	0.11
Neighborhood population density (log transformed)			0.86 (0.77-0.95)	0.003
Neighborhood proportion black			0.73 (0.43-1.23)	0.24
Neighborhood median household income (per \$10,000 increase)			0.97 (0.93-1.02)	0.27