Facility-Level Factors and Racial Disparities in Cardiopulmonary Resuscitation within US Dialysis Clinics

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Key Points

- Clinics caring for Black versus White cardiac arrest patients have significant differences in quality, resources, and patient case mix.
- Accounting for differences in clinic characteristics between Black versus White cardiac arrest patients did not reduce race disparities in cardiopulmonary resuscitation.
- Relative to younger patients, older Black patients were less likely to receive cardiopulmonary resuscitation in dialysis clinics compared with older White patients.

Abstract

Background Cardiac arrest occurs frequently in outpatient dialysis clinics, and immediate cardiopulmonary resuscitation (CPR) provision improves patient outcomes. However, Black patients in dialysis clinics receive CPR from clinic staff less often compared with White patients. We examined the role of dialysis facility resources and patient factors in the observed racial disparity in CPR receipt and automated external defibrillator application.

Methods This was a retrospective cohort study linking the National Cardiac Arrest Registry to Enhance Survival and Medicare Annual Dialysis Facility Report registries from 2013 to 2017. We identified patients experiencing cardiac arrests within US outpatient dialysis clinics via geolocation matching (N=1554). Differences in facility size, quality, staffing, and patient-related factors were summarized and compared according to patient race. Multilevel multivariable logistic regression models including these factors were used to examine the influence of these factors on the observed disparity in CPR rates between Black and White patients.

Results Compared with White patients, Black cardiac arrest patients dialyzed in larger facilities (26 versus 21 dialysis stations; P<0.001), facilities with fewer registered nurses per station (0.29 versus 0.33; P<0.001), and facilities with lower quality scores (# citations 6.8 versus 6.3; P=0.04). Facilities treating Black patients cared for a higher proportion of patients with a history of cardiac arrest (41% versus 35%; P<0.001), HIV/hepatitis B, and Medicaid-enrolled patients (15% versus 11%; P<0.001). Even after accounting for these differences and other covariates, the racial disparity for CPR in Black versus White patients persisted (OR=0.45; 95% CI, 0.27 to 0.75). The racial disparity in CPR was greater among older patients compared with younger patients (interaction P=0.04).

Conclusions The racial disparity in CPR delivery within dialysis clinics was not explained by differences in facility resources and quality. Reducing this disparity will require a multifaceted approach, including developing dialysis clinic-specific protocols for CPR and addressing potential implicit bias.

Introduction Cardiac arrest is the leading cause of death for hemodialysis patients, accounting for 29% of all deaths, and occurs at rates more than 20 times greater than in the general population (1). Out-of-hospital cardiac arrest (OHCA) occurs most frequently on hemodialysis days and often occurs within outpatient dialysis clinics (2–4). Outcomes after cardiac arrest within dialysis clinics are poor, with only 56% survival to hospital admission and 8% survival at 1 year (4). Evidence supports early provision of cardiopulmonary resuscitation (CPR) and rapid defibrillation by
bystanders to increase survival after cardiac arrest (5,6), including cardiac arrest within hemodialysis clinics (7). In a prior study of a national cohort of hemodialysis clinic cardiac arrests, we found that immediate CPR initiated by dialysis clinic staff resulted in a three-fold increase in the odds of survival to hospital discharge. However, the study also found that dialysis staff did not initiate CPR in nearly one out of every five in-center cardiac arrests and did not apply an automated external defibrillator (AED) in almost half of cases (7). Furthermore, there was a troubling association between patient race and the likelihood of staff-provided CPR, with Black patients (odds ratio [OR]=0.41) and Asian patients (OR=0.28) significantly less likely to receive CPR compared with White patients, even after accounting for other patient-level factors (8).

Because dialysis facility-level factors such as staffing levels have been reported to be associated with disparities in important outcomes such as rate of referral for kidney transplantation (9), we hypothesized that they might also contribute to the racial disparity in the rate of staff CPR. For example, it is possible that Black patients are more likely to dialyze at facilities that have lower staffing resources and lower overall quality of care—factors that could underlie lower rates of CPR. Prior studies have also shown that the overall level of patient comorbidity within a dialysis facility is associated with care outcomes (e.g., arteriovenous fistula use) (10). Studies of OHCA in community settings have shown that patients with higher levels of comorbidity are less likely to receive bystander CPR, perhaps because bystanders are more reluctant to initiate CPR for frail patients (11,12). Therefore, we also questioned whether the differential burden of comorbidity (case mix) across facilities may influence observed racial differences in resuscitation rates. In this study, we sought to elucidate the potential association of these and other facility-level factors to understand better the racial disparity in CPR within US dialysis clinics.

Materials and Methods
Data Sources and Study Cohort Selection
The data source and methods we used to identify outpatient dialysis clinic cardiac arrests have been previously described (7). In brief, the study cohort was drawn from the Cardiac Arrest Registry to Enhance Survival (CARES)—a nationwide prospective quality improvement registry of OHCA events in the United States. The registry has been described in detail elsewhere (13,14). CARES includes confirmed OHCA events where resuscitation is attempted, and patients with a do-not-resuscitate order are excluded from the registry by protocol. De-identified data on patient characteristics, resuscitation quality, and outcomes are collected from 911 dispatch centers, emergency medical services (EMS) agencies, and receiving hospitals by a dedicated analyst within participating regions. Event location information is cataloged 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 (15).

For this study, we examined all OHCA events occurring between 2013 and 2017 within the registry catchment area (Supplemental Figure 1). We previously identified dialysis clinic events within CARES using geocoded location information matching with known outpatient hemodialysis clinic locations, and manually reviewed the addresses of all events occurring within a 200 meter radius of an outpatient dialysis clinic, excluding events at nonmatching addresses. This method to identify outpatient hemodialysis clinics has been cross-validated with dialysis clinic records with >95% confirmation of identified events within CARES (7). Because our study focused on the resuscitation efforts by dialysis staff before the arrival of emergency response teams, we excluded OHCA events that were reported as being witnessed on site by 911 responders. We also excluded patients <18 years old, events at locations categorized as private residences, roadways, or nursing homes, and events with missing/incomplete address information. Because 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. Figure 1 summarizes the identification of dialysis clinic events within CARES and development of the final study cohort.

To obtain further information on clinic-level variables, we used publicly published data for US dialysis facilities certified by the Centers for Medicare and Medicaid Services (CMS). Specifically, we extracted data from CMS’s Dialysis Facility Compare online tool, which tracks facility characteristics, quality, and performance (https://data.cms.gov/dialysis-facility-reports/archived) via annually updated summary reports (16). Each dialysis clinic cardiac arrest event in CARES was linked to the corresponding dialysis facility care reports for the matching facility and year of event. If the exact facility could not be identified within CARES (e.g., when two separate dialysis facilities are located at the same street address), these events were excluded.

Covariates and Outcome Measures
Patient-level variables from CARES included age, sex, and race/ethnicity. CARES requires emergency responders to input a single race/ethnicity categorization for each OHCA patient (options include American Indian/Alaska Native, Asian, Black/African American, Hispanic/Latino, Native Hawaiian/Pacific Islander, White, and Unknown).

We targeted potential facility-level predictors on the basis of prior literature (9,17). Variables related to facility resources and staffing included number of patients per dialysis station, ratio of total number of patients to total number of staff members, number of dialysis stations per staff member, and total number of hemodialysis shifts. For facility quality metrics, we used the number of Medicare citations received and facility compliance with CMS conditions of coverage during the year of the event. To examine the association of facility comorbidity burden and case-mix characteristics with outcomes, we used standardized hospitalization ratio, proportion of patients aged >65 years, percentage women, percentage Black race (versus White and all others), the mean length of time on dialysis in years.
(dialysis vintage), and the proportion residing in nursing facilities, each summarized at the facility level. We also examined specific comorbidity domains of interest, including cardiovascular comorbidities (congestive heart failure, history of cardiac arrest), potentially terminal/high morbidity conditions (cancer, chronic obstructive pulmonary disease), and infectious comorbidities (AIDS/HIV, hepatitis B) because we speculated that the prevalence of these conditions might be influential on staff performance of CPR. We also included other reported comorbidities (diabetes, drug dependence) that have been examined in other studies as potential predictors of facility quality of care (10).

Facility-wide data on prevalence of these comorbid conditions are determined in the CMS facility report on the basis of each patient’s Medicare claims for the calendar year, including inpatient stays, outpatient visits, and physician services within the calendar year. A detailed list of ICD-9 and ICD-10 diagnostic codes used to identify comorbidities is available on the CMS Dialysis Facility Compare website at https://dialysisdata.org/content/dfcmethodology. We also examined the reported average number of prevalent comorbidities per patient within the facility, which is a standardized variable reported on the dialysis facility report. The percentage of patients enrolled in Medicaid was examined as a proxy for facility patient income.

Because initiation of CPR is the first critical step in resuscitation efforts, the primary outcome measure was the initiation of CPR by dialysis staff (compared with initiation delayed until arrival of EMS/first responders). We also examined initial AED application by dialysis staff as a secondary outcome measure.

**Statistical Analyses**

We compared the differences in characteristics of facilities that cared for cardiac arrest patients according to patient race (e.g., a facility was considered a Black cardiac arrest facility if the index cardiac arrest patient was Black). Because of the small number of Asian patients in the cohort and insufficient power to examine these subjects fully, we limited our comparisons to Black versus White patients. Group differences between Black and White cardiac arrest facilities were assessed with Pearson chi-squared tests for categorical variables and Wilcoxon rank-sum tests for continuous variables.
To examine independent associations between patient race, clinic characteristics, and staff-initiated CPR and AED application, we used multiple logistic regression models that included patient-level variables (model 1) and subsequently added clinic-level variables (model 2) to examine their contributions. Due to correlation of many of the facility-level variables with each other, and for parsimony, we limited model variables to only variables that were significantly different between Black and White cardiac arrest facilities and those with strong prior rationale as potential mediators of race disparities. We performed checks for collinearity and overfitting on the basis of variance inflation factors, tolerance levels, and condition values to confirm the absence of multicollinearity among variables in the fitted models. To account for the nesting of patients (level 1) within dialysis clinics (level 2), we used two-level hierarchical logistic regression models. Multivariable adjusted odds ratios (ORs) and 95% confidence intervals (CIs) were estimated from the multilevel models, with a P value <0.05 considered statistically significant. We also included interaction terms to identify potential racial differences in associations between the primary outcomes and other patient and facility-level characteristics.

All analyses were performed using Stata v15.0 (Stata-Corp, College Station, TX). To reduce bias in estimation and to preserve the numbers of patients included in our analyses, we used multiple imputation methods (chained equations) to impute data for missing values of covariates in the models (18). The study was approved by the Duke University Institutional Review Board (Pro00100893).

Results
A total of 1554 cardiac arrest events occurred within 803 unique dialysis clinics; of these, 485 patients were identified as White and 508 as Black. Table 1 examines the characteristics of these patients and their facilities according to patient race. Compared with White cardiac arrest patients, Black patients were significantly younger (64.3 versus 65.9 years) and more likely to be men (52% versus 39%) compared with non-Black patients.

There were notable differences in facility size and staffing resources between Black and White cardiac arrest patients. Black patients dialyzed in larger facilities (mean 25.7 versus 20.9 dialysis chairs) treating more patients (mean 95.1 versus 77.3). The average number of nurses (0.29) and patient care technicians (0.42) per dialysis chair was lower in facilities caring for Black patients compared with White patient facilities (P<0.001). Facilities caring for Black cardiac arrest patients had a lower rate of full compliance with CMS conditions of coverage (37%) and a higher number of citations (6.8); however, other quality metrics such as facility prevalent arteriovenous fistula/graft use did not differ. Black cardiac arrest patients largely dialyzed within Black patient-predominant facilities. There was a higher prevalence of patients receiving Medicaid within clinics treating Black cardiac arrest patients.

Comparing the overall comorbidity burden within facilities according to patient race also revealed notable differences. The proportion of patients >65 years old was substantially lower among Black cardiac arrest facilities (40% versus 48% in White cardiac arrest facilities; P<0.001). Although there were no overall differences in the average total number of comorbidities per patient within facilities according to patient race, a history of cardiac arrest was less prevalent, and infectious diseases such as HIV/AIDS and hepatitis B were more prevalent in Black cardiac arrest patient facilities.

Overall, 15% of Black cardiac arrest patients did not receive CPR from dialysis staff compared with 9% of White patients and 12% of other/unknown race; 40% of Black cardiac arrest patients did not have an AED applied by dialysis staff compared with 34% of White patients and 40% of other/unknown race. Figure 2 presents the likelihood of Black patients receiving CPR and AED compared with White patients, after adjustment for patient and facility factors. Without covariate adjustment, the likelihood of receiving CPR by dialysis staff was significantly lower for Black patients (OR=0.52; 95% CI, 0.34 to 0.81). After accounting for all relevant patient characteristics, facility resources, quality measures, and facility comorbidities, there was a stronger negative association between Black race and receipt of staff CPR (OR=0.43; 95% CI, 0.26 to 0.74). Of the facility-level variables examined, only facility prevalence of hepatitis B (OR=0.97; 95% CI, 0.95 to 0.99), the mean per-patient number of comorbidities (OR=1.97; 95% CI, 1.09 to 3.59), and the facility prevalence of illicit drug users (OR=0.92; 95% CI, 0.86 to 0.99) were independently associated with staff CPR provision (Table 2).

Considering AED application by dialysis staff, the likelihood was also lower among Black patients in unadjusted models (OR=0.76; 95% CI, 0.58 to 0.99), but after accounting for other patient and facility factors, there was no significant difference according to patient race (OR=0.93; 95% CI, 0.68 to 1.27; Figure 3). A higher patient care technician to nurse ratio (OR=0.75; 95% CI, 0.61 to 0.91) and a higher facility prevalence of Black patients (OR=0.99; 95% CI, 0.98 to 0.99) were independently associated with the decreased likelihood of staff AED application, whereas higher facility prevalence of congestive heart failure was independently associated with an increased likelihood of staff AED application (OR=1.02; 95% CI, 1.01 to 1.04; Table 2).

Interaction analyses did not uncover significant interactions between key facility factors and the magnitude of the disparity in staff CPR between Black and White patients; however, a significant interaction was noted between patient age and race (P=0.04). As shown in Figure 4, the racial disparity in staff CPR was more pronounced among older patients.

Discussion
In this nationwide study of dialysis clinic cardiac arrests, we investigated the role of facility-level factors in race disparities in bystander CPR. In summary, we found that despite significant differences in facility staffing resources, quality measures, and comorbidity levels between dialysis facilities caring for Black versus White cardiac arrest patients, accounting for these differences did not eliminate or reduce the race disparity in CPR, suggesting that the observed disparity is due to other factors.

Although facility staffing levels did not account for the race disparity in CPR, we also examined whether staffing
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Table 1. Patient and facility-level characteristics of dialysis clinic cardiac arrest events according to patient race

| Variable                                      | White | Black | P Value |
|-----------------------------------------------|-------|-------|---------|
| **Patient characteristics**                  |       |       |         |
| Age, yr                                       | 65.9 (12.3) | 64.3 (12.9) | 0.04 |
| Women                                         | 188/485 (61%) | 257/508 (49%) | <0.001 |
| **Cardiac arrest characteristics**            |       |       |         |
| Witnessed arrest                              | 419/485 (86%) | 429/508 (84%) | 0.39 |
| Saturday event                                | 60/485 (12%) | 62/508 (12%) | 0.96 |
| Third shift or later                          | 120/485 (25%) | 106/508 (21%) | 0.29 |
| **Facility characteristics**                 |       |       | 0.24   |
| Type of unit                                  |       |       |         |
| Nonprofit, non-chain                          | 11/485 (2%) | 4/508 (0.8%) |       |
| Nonprofit chain                               | 43/485 (9%) | 39/508 (8%) |       |
| Profit, non-chain                             | 12/485 (3%) | 13/508 (3%) |       |
| Profit chain                                  | 419/485 (86%) | 452/508 (89%) |       |
| Total in-center HD patients                   | 77.3 (37.9) | 95.1 (44.7) | <0.001 |
| Total dialysis stations                       | 20.9 (8.5) | 25.7 (10.8) | <0.001 |
| Number of patients per station                | 3.7 (1.2) | 3.8 (1.1) | 0.2 |
| Number of total staff per station             | 1.32 (0.4) | 1.28 (0.4) | 0.04 |
| Number of patient care technicians per station| 0.43 (0.21) | 0.42 (0.18) | <0.001 |
| Number of RNs per station                     | 0.33 (0.4) | 0.29 (0.15) | 0.02 |
| PCT/RN ratio (total staff)                    | 1.5 (0.7) | 1.6 (0.8) | 0.08 |
| **Medicare quality metrics**                  |       |       |         |
| Compliance with CMS conditions of coverage    | 221/484 (46%) | 185/505 (37%) | 0.01 |
| # citations                                   | 6.3 (5.4) | 6.8 (5.3) | 0.02 |
| **Facility patient case mix characteristics**|       |       |         |
| Standardized hospitalization ratio (observed/expected) | 0.997 (0.2) | 1.02 (0.2) | 1.0 |
| % facility with age >65 yr                    | 47.6 (10.5) | 39.8 (9.2) | <0.001 |
| % facility women                              | 42.7 (6.6) | 43.9 (5.9) | 0.004 |
| **Race composition of facility**              |       |       |         |
| % White                                       | 66.2 (23) | 31.1 (22.2) | <0.001 |
| % Black                                       | 28.2 (23) | 65.7 (24.2) | <0.001 |
| % Other                                       | 0.3 (0.9) | 0.2 (0.5) | <0.001 |
| **Pre-existing conditions at ESRD diagnosis** |       |       |         |
| % with inability to ambulate                   | 6.4 (8.4) | 6.8 (10.5) | 0.51 |
| % with inability to transfer                   | 3 (5.7) | 3.8 (8.8) | 0.97 |
| # comorbidities                               | 3.2 (0.8) | 3 (0.9) | 0.19 |
| **Facility prevalent dialysis access**        |       |       |         |
| % AVF/AVG                                     | 78.3 (10.6) | 78.8 (9.4) | 0.87 |
| % catheter                                    | 16.6 (6.9) | 15.8 (6.2) | 0.07 |
| Average number of comorbidities               | 5.0 (0.6) | 4.9 (0.6) | 0.09 |
| **Prevalent comorbidities (%)**               |       |       |         |
| HIV/AIDS                                      | 1.3 (1.8) | 3 (3) | <0.001 |
| Hepatitis B                                   | 1.6 (6.3) | 2.1 (6.6) | <0.001 |
| History of cardiac arrest                     | 40.5 (11) | 35.1 (9.1) | <0.001 |
| Congestive heart failure                      | 52.1 (9.4) | 51.9 (9.7) | 0.81 |
| Cardiovascular disease                        | 21.8 (8.2) | 22.5 (8.1) | 0.47 |
| Cancer                                        | 11.2 (5.9) | 10.2 (5.2) | 0.001 |
| COPD                                          | 33.2 (8.9) | 30.7 (8.5) | <0.001 |
| History of drug use                           | 3 (2.6) | 3.4 (2.5) | 0.002 |
| History of diabetes                           | 63.5 (8.9) | 63.8 (9.2) | <0.001 |
| **Insurance status**                          |       |       |         |
| % Medicaid only patients                      | 10.9 (9.2) | 15.1 (11.8) | <0.001 |

Mean (standard deviation) listed unless otherwise noted. HD, hemodialysis; RN, registered nurse; PCT, patient care technician; CMS, Center for Medicare and Medicaid Services; AVF/AVG, arteriovenous fistula/graft; COPD, chronic obstructive pulmonary disease.
Figure 2. Likelihood of receiving staff cardiopulmonary resuscitation (Blacks compared with Whites). Circles represent odds ratios, and line/whisker represents 95% confidence intervals. Values < 1 indicate decreased likelihood of intervention. Adjusted sequentially for patient characteristics, facility quality measures, facility comorbidity prevalence, and facility resource and socioeconomic status (SES) variables as shown.

Table 2. Multivariable predictors of Staff CPR and AED Placement

| Variable                                | Likelihood of Staff Cardiopulmonary Resuscitation, Odds Ratio (95% Confidence Interval) | P Value | Likelihood of Staff Automated External Defibrillator Placement, Odds Ratio (95% Confidence Interval) | P Value |
|-----------------------------------------|----------------------------------------------------------------------------------------|---------|-------------------------------------------------------------------------------------------------|---------|
| Black race (versus White)               | 0.44 (0.26 to 0.74)                                                                   | 0.002   | 0.93 (0.6 to 1.27)                                                                               | 0.64    |
| Other/unknown race (versus White)       | 0.69 (0.44 to 1.08)                                                                   | 0.11    | 0.76 (0.58 to 1)                                                                                 | 0.05    |
| **Patient-level variables**             |                                                                                        |         |                                                                                                |         |
| Age, yr                                 | 0.99 (0.98 to 1.01)                                                                   | 0.28    | 1 (0.99 to 1)                                                                                    | 0.3     |
| Men                                     | 1.27 (0.91 to 1.79)                                                                   | 0.16    | 1.08 (0.87 to 1.35)                                                                              | 0.46    |
| Witnessed arrest                         | 1.81 (1.19 to 2.75)                                                                   | 0.005   | 1.28 (0.95 to 1.71)                                                                              | 0.11    |
| Saturday event                           | 0.79 (0.49 to 1.25)                                                                   | 0.31    | 0.96 (0.7 to 1.32)                                                                               | 0.81    |
| Late shift event                         | 0.88 (0.58 to 1.3)                                                                   | 0.58    | 0.91 (0.7 to 1.19)                                                                               | 0.5     |
| **Facility-level variables**            |                                                                                        |         |                                                                                                |         |
| % age >65 yr                             | 1 (0.98 to 1.02)                                                                      | 0.1     | 1 (0.99 to 1)                                                                                    | 0.3     |
| % women                                  | 1 (0.97 to 1.03)                                                                      | 0.98    | 1 (0.98 to 1.02)                                                                                 | 0.84    |
| % Black race                             | 1.01 (1 to 1.01)                                                                      | 0.22    | 0.99 (0.99 to 1)                                                                                 | 0.02    |
| % residing in nursing facility           | 1 (0.97 to 1.02)                                                                      | 0.75    | 1 (0.99 to 1.02)                                                                                 | 0.62    |
| % Medicaid only                          | 0.99 (0.98 to 1.01)                                                                   | 0.6     | 1.01 (1 to 1.02)                                                                                 | 0.15    |
| Number of HD patients                    | 1 (1 to 1.01)                                                                         | 0.26    | 1 (0.99 to 1)                                                                                    | 0.29    |
| PCT-to-nurse ratio                       | 0.81 (0.61 to 1.05)                                                                   | 0.26    | 0.75 (0.61 to 0.91)                                                                              | 0.004   |
| Patient-to-station ratio                 | 1.09 (0.86 to 1.37)                                                                   | 0.5     | 0.92 (0.8 to 1.06)                                                                               | 0.27    |
| Nurse-to-station ratio                   | 0.45 (0.16 to 1.23)                                                                   | 0.12    | 0.69 (0.32 to 1.48)                                                                              | 0.34    |
| PCT-to-station ratio                     | 1.96 (0.46 to 8.29)                                                                   | 0.36    | 1.92 (0.75 to 4.91)                                                                              | 0.18    |
| Annual compliance with Medicare quality standards | 0.94 (0.65 to 1.38)                                                                   | 0.76    | 1.17 (0.92 to 1.47)                                                                              | 0.2     |
| # of annual Medicare citations           | 0.98 (0.95 to 1.01)                                                                   | 0.28    | 1.01 (0.99 to 1.03)                                                                              | 0.32    |
| % AIDS                                  | 1.01 (0.93 to 1.10)                                                                   | 0.85    | 1.05 (0.99 to 1.1)                                                                               | 0.11    |
| % hepatitis B                            | 0.97 (0.95 to 0.99)                                                                   | 0.03    | 1 (0.98 to 1.02)                                                                                 | 0.91    |
| % history cardiac arrest                 | 0.99 (0.97 to 1.02)                                                                   | 0.49    | 1.01 (0.99 to 1.02)                                                                              | 0.31    |
| % congestive heart failure              | 1 (0.97 to 1.02)                                                                      | 0.93    | 1.02 (1.01 to 1.04)                                                                              | 0.007   |
| % cardiovascular disease                 | 0.98 (0.95 to 1.0)                                                                   | 0.09    | 0.99 (0.98 to 1.01)                                                                              | 0.36    |
| % cancer                                | 1 (0.96 to 1.03)                                                                      | 0.78    | 1.02 (1 to 1.04)                                                                                 | 0.09    |
| % drug use                               | 0.92 (0.86 to 0.99)                                                                   | 0.02    | 1.02 (0.97 to 1.07)                                                                              | 0.41    |
| Mean number comorbidities per patient    | 1.97 (1.09 to 3.59)                                                                   | 0.03    | 0.73 (0.51 to 1.06)                                                                              | 0.1     |

Values >1 indicate an increased likelihood of staff resuscitation procedures. HD, hemodialysis; PCT, patient care technician.
metrics with either staff CPR performance or AED deployment. However, we did observe that clinics with a lower proportion of registered nurses on staff compared with patient care technicians had a significantly lower likelihood of AED deployment. Because both technicians and nurses provide direct patient care in most dialysis clinics, this finding suggests that increasing the number of nurses, who have more clinical training, or increasing the level of training for all staff could improve resuscitation performance in dialysis clinics. Consistent with this notion, other studies have shown that there is an increased likelihood of CPR provision among bystanders with higher levels of education (19).

Although facility comorbidity levels did not influence the racial disparity in CPR, we also hypothesized that facility comorbidity levels might be associated with overall rates of staff CPR. At a patient level, comorbidity burden is known to associate with lower rates of OHCA survival and also lower rates of bystander CPR (11,12). At a facility level, comorbidity burden often negatively affects facility quality measures, and thus performance reports for many metrics are adjusted for facility-level comorbidity burden (20). However, in regard to staff CPR performance, surprisingly, we found that facilities with a higher burden of comorbidity had an increased likelihood of staff CPR. Additionally, we also found a higher likelihood of AED deployment within facilities with a higher prevalence of a specific comorbidity: congestive heart failure. Taken together, we speculate that these findings suggest that clinics with greater exposure to sicker patients, particularly those with cardiac disease, might have greater awareness and preparedness for cardiac arrest resuscitation. On the other hand, we observed a lower likelihood of CPR within dialysis facilities with higher prevalence...
of patients with hepatitis B; in this case, it is possible that the clinic isolation precautions needed to care for hepatitis B patients could reduce patient monitoring by staff and thus result in lower CPR rates. Overall, these findings suggest that increasing staff training and readiness to perform CPR in dialysis clinics could be a strategy to address deficiencies in resuscitation care for all patients—an approach that has been previously identified by dialysis staff as a significant need (21).

The decreased probability of older Black patients to receive CPR compared with older White patients is noteworthy. Older age has been shown to be associated with less intensive resuscitation care in prior studies, even though international guidelines do not consider age as a criterion to decide whether to attempt or withhold resuscitation (22,23). This could reflect reluctance to institute maximal treatment for older OHCA patients due to concern for futility or poor functional outcomes. Additionally, it is well documented that older Black patients are less likely to have advanced directives in place compared with older White patients (24,25). Although a preexisting do-not-resuscitate order was an automatic exclusion criterion for the CARES registry, it is possible that the racial disparity among older patients could reflect greater uncertainty on the part of providers in regard to the resuscitation wishes of older Black patients. A greater emphasis on engaging older Black patients in advanced care discussions to understand their wishes might be a practical means to address the race disparity, but further research is needed to determine if uncertainty about advanced directives is a significant barrier to providing resuscitation within dialysis clinics.

Because the racial disparity persisted after controlling for multiple patient- and facility-level factors, it is possible that implicit biases held by dialysis clinic staff played a role. Implicit bias is well documented among health care professionals (26,27) and has been associated with racial disparities in treatment decisions and important health outcomes (28,29). The effect of implicit bias can be exacerbated in situations where health care providers face time pressure, stress, and uncertainty due to complex medical problems—all factors that are present during a dialysis clinic code event (21,30). Demonstrating the influence of implicit bias is difficult, and it is surely not the only cause of racial disparities in care, but the evidence of its ubiquitous presence and association with outcomes makes it a likely contributor and a possible target for intervention.

An important first step toward addressing potential implicit bias as a strategy for reducing disparity is to increase provider awareness of the disparity itself. For example, even though racial disparities in dialysis clinic referral for kidney transplantation have been extensively reported, a recent study reported that <20% of dialysis providers from low-waitlisting dialysis facilities reported awareness of the national disparity, with only 5% reporting awareness of racial differences that existed within their own facility (31). If dialysis clinic staff are unaware of racial disparities, they are unlikely to take intentional action to address it. Awareness of implicit bias may help reduce it (32), but there is also evidence that awareness alone is insufficient—both knowledge and skills designed to manage one’s implicit bias (such as individuation rather than categorization) are also necessary to mitigate the effect of implicit bias on care successfully (33,34). Further research is needed to determine what effect intervention (e.g., implicit bias training) that increases awareness, knowledge, and skill has on racial disparities in delivery of care in dialysis clinics, including resuscitation delivery.

Our study has important limitations. First, our cohort size was relatively small, and due to the small sample size, we were unable examine the contribution of facility factors with race disparities among Asians. However, given the lack of any meaningful change in the disparity observed in Black patients, it is unlikely that facility factors explain disparities seen among Asians. Second, we did not have data on other facility-level factors that may have affected the delivery of CPR or AED application. For instance, we did not have data on racial composition of clinic staff members, which would have enabled us to examine the influence patient-staff race concordance on performance of resuscitation procedures. Racially concordant care has been shown to result in improved communication, overall care, and improved health outcome (35). Third, even though CARES has a catchment of more than 167 million people, it represents 51% of the US population base and may not be generalizable to other areas of the United States. Fourth, 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. Finally, although the primary focus of this analysis was on facility-level factors, we did not examine the association of patient-level comorbidities with staff CPR. Patient comorbidities could influence staff willingness to perform CPR and might underlie the observed racial disparities, but because the CARES registry excluded patients with do-not-resuscitate orders, every instance of lack of staff CPR represents a deficiency in care, regardless of patient health status.

In conclusion, race disparities in staff CPR within dialysis clinics were not explained by differences in facility-level factors. In contrast, our findings emphasize the critical importance of improving all aspects of the resuscitation response in dialysis clinics to ensure that all patients who desire resuscitation, regardless of race, receive high-quality CPR. Efforts to improve cardiac arrest recognition, quality of dialysis-specific CPR training and protocols, and implementation of implicit bias training may be needed to reduce racial disparities and improve overall care.

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Author Contributions

M.E. Dupre was responsible for supervision and Validation; M.E. Dupre and P.H. Pun were responsible for data curation, formal analysis, investigation, and methodology; M.E. Dupre, P.H. Pun, and L.P. Svetkey wrote the original draft of the manuscript; B. McNally was responsible for resources; P.H. Pun was responsible for conceptualization, funding acquisition, and project administration; and all authors reviewed and edited the manuscript.

Supplemental Material

This article contains the following supplemental material online at http://kidney360.asnjournals.org/lookup/suppl/doi:10.34067/KID.0008092021/-/DSSupplemental.

Supplemental Figure 1. Map of CARES-participating states and municipalities included in study cohort.

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