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# Cardiac Arrest Survival at Emergency Medical Service Agencies in Catchment Areas With Primarily Black and Hispanic Populations

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**IMPORTANCE** Black and Hispanic patients are less likely to survive an out-of-hospital cardiac arrest (OHCA) than White patients. Given the central importance of emergency medical service (EMS) agencies in prehospital care, a better understanding of OHCA survival at EMS agencies that work in Black and Hispanic communities and White communities is needed to address OHCA disparities.

**OBJECTIVE** To examine whether EMS agencies serving catchment areas with primarily Black and Hispanic populations (Black and Hispanic catchment areas) have different rates of OHCA survival than agencies serving catchment areas with primarily White populations (White catchment areas).

**DESIGN, SETTING, AND PARTICIPANTS** A cohort study including adults with nontraumatic OHCA from January 1, 2015, to December 31, 2019, in the Cardiac Arrest Registry to Enhance Survival was conducted. Data analysis was conducted from August 17, 2022, to July 7, 2023.

**EXPOSURE** Emergency medical service agencies, categorized as working in catchment areas where the combination of Black and Hispanic residents made up more than 50% of the population or where White residents made up more than 50% of the population.

**MAIN OUTCOMES AND MEASURES** The unit of analysis was the EMS agency. The primary outcome was agency-level risk-standardized survival rates (RSSRs) to hospital admission for OHCA at each EMS agency, which were calculated using hierarchical logistic regression and compared between agencies serving Black and Hispanic and White catchment areas. Whether differences in OHCA survival were explained by EMS and first responder measures was evaluated with additional adjustment for these factors.

**RESULTS** Among 764 EMS agencies representing 258 342 OHCAs, 82 EMS agencies (10.7%) had a Black and Hispanic catchment area. Overall median age of the patients was 63.0 (IQR, 52.0-75.0) years, 36.1% were women, and 63.9% were men. Overall, the mean (SD) RSSR was 27.5% (3.6%), with lower survival at EMS agencies with Black and Hispanic catchment areas (25.8% [3.6%]) compared with agencies with White catchment areas (27.7% [3.5%]; $P < .001$). Among the 82 EMS agencies with Black and Hispanic catchment areas, a disproportionately higher number (32 [39.0%]) was in the lowest survival quartile, whereas a lower number (12 [14.6%]) was in the highest survival quartile. Additional adjustment for EMS response times, EMS termination of resuscitation rates, and first responder rates of initiating cardiopulmonary resuscitation or applying an automated external defibrillator before EMS arrival did not meaningfully attenuate differences in RSSRs between agencies with Black and Hispanic compared with White catchment areas (mean [SD] RSSRs after adjustment, 25.9% [3.3%] vs 27.7% [3.1%]; $P < .001$).

**CONCLUSIONS AND RELEVANCE** Risk-standardized survival rates for OHCA were 1.9% lower at EMS agencies working in Black and Hispanic catchment areas than in White catchment areas. This difference was not explained by EMS response times, rates of EMS termination of resuscitation, or first responder rates of initiating cardiopulmonary resuscitation or applying an automated external defibrillator. These findings suggest there is a need for further assessment of these discrepancies.

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Supplemental content

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In the US, Black and Hispanic patients with out-of-hospital cardiac arrest (OHCA) have lower survival rates than White patients.[1-3] This disparity may be due, in part, to lower rates of prehospital survival at emergency medical service (EMS) agencies that work in Black and Hispanic communities. Given the central importance of EMS agencies in the chain of survival for OHCA, a better understanding of OHCA survival rates at EMS agencies serving catchment areas with primarily Black and Hispanic populations (>50% of residents) (Black and Hispanic catchment areas) compared with agencies serving catchment areas with primarily White populations (>50% of residents) (White catchment areas) may illuminate strategies to improve equity in OHCA care. However, little is known about the extent to which OHCA survival at agencies serving Black and Hispanic catchment areas differs from those primarily serving White catchment areas.

Although several studies have reported racial and ethnic differences in OHCA care or survival by census tract or region,[2-5] these studies focused on differences by geography, which is not modifiable and does not have easily identifiable resuscitation infrastructure or leadership to target interventions. In contrast, a focus on survival differences at the EMS agency level could identify opportunities for improving prehospital care. For instance, if EMS agencies with Black and Hispanic catchment areas have lower survival rates for OHCA, it would be important to understand whether system-level data captured in an OHCA registry (eg, EMS response times, resuscitation termination rates) account for the lower OHCA survival rates or whether new research is needed to identify barriers and challenges to resuscitation care at these EMS agencies.

To address this gap in knowledge, we examined the extent to which EMS agencies with Black and Hispanic catchment areas have different survival rates for OHCA compared with agencies with White catchment areas. Furthermore, we examined whether several EMS and first responder measures accounted for differences in OHCA survival between these agency types.

### Key Points

**Question** Do emergency medical service (EMS) agencies that work in Black and Hispanic communities have lower survival rates for out-of-hospital cardiac arrest (OHCA) than agencies in White communities?

**Findings** In this cohort study among 764 EMS agencies in the US, 82 had a catchment area with primarily Black and Hispanic populations; EMS agencies with such catchment areas had lower survival rates to hospital admission for OHCA than agencies with catchment areas with primarily White populations. Survival differences were not explained after adjusting for EMS and first responder metrics.

**Meaning** The findings of this study suggest that to understand disparities in OHCA survival, new approaches are needed to identify barriers to resuscitation care at EMS agencies serving Black and Hispanic communities.

## Methods

### Data Source

In this cohort study, we used data from the Cardiac Arrest Registry to Enhance Survival (CARES), a prospective multicenter registry of OHCA in the US. The design of CARES has been previously described.[6] Founded in 2004, CARES now comprises 30 state-based registries and the District of Columbia, with community sites in 16 additional states, constituting a total catchment area of over 175 million residents (eFigure 1 in Supplement 1). Briefly, all patients with a confirmed OHCA (defined as pulselessness, apnea, and unresponsiveness) and for whom resuscitation is attempted are identified. Data are collected from 911 dispatch centers, EMS agencies, and receiving hospitals. Patient variables and outcomes are reported using the international Utstein standard to ensure uniformity of data collection.[7] Each event is verified by a CARES analyst for completeness and accuracy. The study adhered to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guideline for observational studies and was approved by Saint Luke's Hospital's Institutional Review Board, which waived the requirement for informed consent, as the study involved deidentified data.

### Study Population

Between January 1, 2015, and December 31, 2019, we identified 377 475 nontraumatic OHCAs at 1449 EMS agencies (eFigure 2 in Supplement 1). We excluded 10 356 individuals younger than 18 years, as our focus was on adults. We further excluded 14 270 OHCAs occurring in a health care facility, 41 297 in a nursing home, 1455 at a transport center, and 2 with an unknown location. In addition, we excluded 1785 drowning and 236 electrocution events and 40 821 OHCAs witnessed by EMS personnel. As our study was a site-level analysis, we excluded 8350 OHCAs at EMS agencies with fewer than 10 OHCA cases annually or fewer than 20 OHCA cases if the agency had less than 2 years of participation. In addition, we excluded 561 OHCAs with unknown survival status. Our final cohort included 258 342 OHCAs at 764 EMS agencies.

### Defining EMS Agency Catchment Areas

The goal was to compare EMS agencies by the racial and ethnic makeup of their catchment area for emergency response. Emergency medical service agencies serving Black and Hispanic catchment areas were defined as those in which the majority (>50%) of residents in their coverage area were of Black race or Hispanic ethnicity, whereas EMS agencies serving White catchment areas were those in which the majority of residents were either of White or Asian race. We determined a priori to group Black and Hispanic residents into a combined catchment area group based on recent work examining these 2 racial and ethnic groups jointly[8] and prior work showing lower rates of OHCA survival for both patient groups.[1-3] To determine the racial and ethnic composition of the catchment area for each EMS agency, the address of each OHCA was geocoded to a US

Census tract. Then, neighborhood-level information on race and ethnicity for each census tract was obtained from self-reported race and ethnicity data in the 2019 American Community Survey.[9] As an EMS agency catchment area often involved more than 1 census tract, we calculated the racial and ethnic composition of the catchment area for each EMS agency by weighting the racial and ethnic composition of each census tract served by that agency with the proportion of OHCA events that occurred in the census tract. For instance, if an agency had 100 OHCAs during the study period, with 50 OHCAs in a census tract that was 50% Black and Hispanic and 50 OHCAs in a census tract that was 80% Black and Hispanic, that agency would be categorized as serving a Black and Hispanic catchment area as its weighted racial and ethnic composition would be 65% Black and Hispanic (additional example in eTable 1 in Supplement 1).

## Outcomes

The unit of analysis was the EMS agency. The primary outcome was agency-level rates of survival to hospital admission, defined as admission to an inpatient hospital unit. We focused on prehospital survival, as this is the outcome primarily associated with EMS agency resuscitation efforts.

## EMS Agency and First Responder Metrics

We evaluated whether 3 EMS agency metrics available in CARES accounted for potential differences in OHCA survival between catchment area type. Since EMS response time (time from 911 call to EMS arrival) is a key determinant of survival, we assessed whether EMS agencies with Black and Hispanic and White catchment areas had different EMS response times. We also evaluated 2 termination of resuscitation (TOR) rates by EMS agency type. Among all patients with OHCA who had TOR at an agency, we determined the proportion of patients who met all 4 futility criteria (ie, <1% likelihood of overall survival) for termination (unwitnessed arrest, nonshockable arrest rhythm, no bystander cardiopulmonary resuscitation [CPR], and no return of spontaneous circulation despite resuscitation efforts)[10] and the proportion of patients who had termination despite not meeting futility criteria. Moreover, we evaluated 2 first responder measures at each EMS agency: the proportion of OHCAs without bystander CPR in which first responders (fire and police) initiated CPR and the proportion of OHCAs in which first responders first applied an automated external defibrillator (AED).

## Statistical Analysis

Data analysis was conducted from August 17, 2022, to July 7, 2023. For each EMS agency, we calculated risk-standardized survival rates (RSSRs) to hospital admission to facilitate comparisons. This approach has been used to benchmark survival outcomes, such as for acute myocardial infarction and heart failure.[11,12] To accomplish this, we constructed a hierarchical logistic regression model with EMS agency as a random effect and the following variables as fixed effects: age, sex, whether the arrest was witnessed, location of arrest (home, workplace, street/highway, industrial building, recreational facility, or other), etiology of arrest (presumed cardiac, respiratory, drug overdose, and other), receipt of bystander CPR, initially detected cardiac arrest rhythm, and urbanicity of the OHCA location (US Census tract classification: urbanized [≥50 000 residents], urban cluster [nonurbanized areas with ≥2500 residents], or rural [<2500 residents]).[13] Consistent with risk standardization of survival outcomes for other cardiac conditions,[11,12] patient race and ethnicity was not included in the model. Using the agency-specific estimates (ie, random intercepts) from the hierarchical model, we then calculated RSSRs for each EMS agency by multiplying the registry's overall survival rate by the ratio of each EMS agency's predicted to expected number of survivors.[14,15] The expected number of OHCA survivors at an agency was determined using the average intercept from all sites, whereas the predicted number of OHCA survivors was determined using the agency's individual random effect intercept.

We then examined the racial and ethnic composition of an EMS agency's catchment area and its RSSR. First, we summarized the distribution of RSSRs separately for EMS agencies with Black and Hispanic catchment areas and White catchment areas and graphed the distributions within each group using nonparametric kernel density estimation.[16] The mean survival rates between the 2 groups were then compared using cluster bootstrapping.[17] For descriptive purposes, we stratified EMS agencies into quartiles of RSSR and examined the proportion of EMS agencies with Black and Hispanic catchment areas in each survival quartile.

Next, we compared rates of each aforementioned EMS agency and first responder measure between EMS agencies with Black and Hispanic catchment areas and White catchment areas using mixed-effects regression models (log-linear for EMS response time, logistic for the other metrics), with EMS agency as a random effect for each comparison. To assess whether these EMS agency and first responder metrics explained potentially lower survival rates at EMS agencies with Black and Hispanic catchment areas, we then adjusted for these measures in the hierarchical model described above in sequential order (first for the 3 EMS agency metrics and then with EMS agency and first responder metrics in the model) and assessed whether survival differences for OHCA between EMS agencies with Black and Hispanic compared with White catchment areas were attenuated.

Census tract–level race and ethnicity information was unavailable for 40 (5.2%) of the 764 agencies. For these agencies, we imputed racial and ethnic composition using multiple imputation based on available data, including OHCA case characteristics, EMS agency racial and ethnic composition, other census tract–level information, and EMS agency metrics. We generated 96 multiply imputed data sets and used the mean of the 96 multiply imputed values for each of the 40 agencies.

All analyses were evaluated at a 2-sided significance level of $P < .05$ and performed with SAS, version 9.4 (SAS Institute Inc) and R, version 3.6.3 (R Foundation for Statistical Computing).

Table 1. Patient Characteristics by EMS Agency Catchment Area

| Characteristic | Black and Hispanic catchment area (n = 74 451)[a] | White catchment area (n = 183 891)[b] |
|---|---|---|
| Age, median (IQR), y | 62.0 (51.0-74.0) | 64.0 (52.0-75.0) |
| Sex | | |
| Female | 28 922 (38.8) | 64 332 (35.0) |
| Male | 45 529 (61.2) | 119 548 (65.0) |
| Missing | 0 | 11 |
| Race and ethnicity[c] | | |
| American Indian or Alaska Native | 179 (0.3) | 823 (0.6) |
| Asian | 1262 (1.9) | 4462 (3.2) |
| Black | 32 110 (49.0) | 22 739 (16.1) |
| Hispanic | 9499 (14.5) | 6296 (4.5) |
| Native Hawaiian or Other Pacific Islander | 170 (0.3) | 1007 (0.7) |
| White | 22 295 (34.0) | 105 558 (74.9) |
| Missing | 8936 | 43 006 |
| Urbanicity[d] | | |
| Rural | 1393 (1.9) | 24 060 (13.1) |
| Urban cluster | 942 (1.3) | 14 591 (7.9) |
| Urbanized area | 71 955 (96.9) | 144 948 (78.9) |
| Missing | 161 | 292 |
| Location of arrest | | |
| Home | 60 539 (81.3) | 152 073 (82.7) |
| Public location | | |
| Commercial building | 5809 (7.8) | 17 241 (9.4) |
| Street | 6731 (9.0) | 9462 (5.1) |
| Place of recreation | 892 (1.2) | 3293 (1.8) |
| Industrial place | 314 (0.4) | 1093 (0.6) |
| Other | 166 (0.2) | 729 (0.4) |
| Witnessed status | | |
| Witnessed | 30 148 (40.5) | 83 548 (45.4) |
| Unwitnessed | 44 303 (59.5) | 100 337 (54.6) |
| Missing | 0 | 6 |
| Presumed cause | | |
| Presumed cardiac | 64 663 (86.9) | 154 877 (84.2) |
| Respiratory | 4340 (5.8) | 13 725 (7.5) |
| Drug overdose | 3805 (5.1) | 9486 (5.2) |
| Exsanguination | 247 (0.3) | 869 (0.5) |
| Other | 1396 (1.9) | 4934 (2.7) |
| Layperson bystander CPR | 24 595 (33.0) | 76 577 (41.6) |
| First monitored rhythm | | |
| Asystole | 41 353 (55.5) | 91 811 (49.9) |
| Pulseless electrical activity | 13 632 (18.3) | 32 824 (17.9) |
| Unknown unshockable rhythm | 7251 (9.7) | 17 378 (9.5) |
| Ventricular fibrillation | 9010 (12.1) | 30 242 (16.4) |
| Ventricular tachycardia | 553 (0.7) | 1901 (1.0) |
| Unknown shockable rhythm | 2650 (3.6) | 9714 (5.3) |
| Missing | 2 | 21 |
| Survived to hospital discharge | 5539 (7.4) | 19 751 (10.7) |
| Missing | 10 | 12 |
| Favorable neurologic survival | 3648 (4.9) | 16 929 (9.2) |
| Missing | 291 | 34 |

Abbreviations: CPR, cardiopulmonary resuscitation; EMS, emergency medical service.

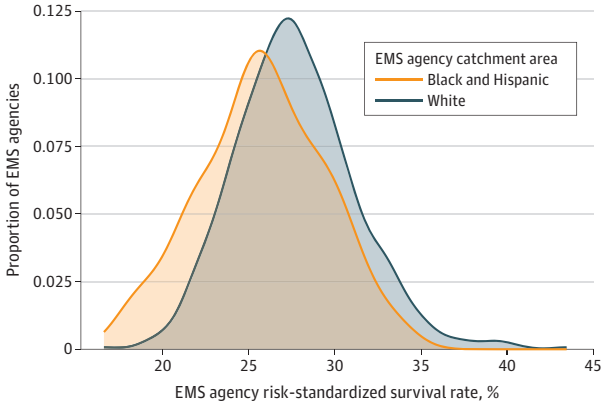
[a] Catchment areas with primarily Black and Hispanic populations (>50% of residents).

[b] Catchment areas with primarily White populations (>50% of residents).

[c] Percentages of those with known race or ethnicity.

[d] Urbanized defined as 50 000 or more residents; urban cluster, nonurbanized areas with 2500 or more residents; and rural, less than 2500 residents.

Figure. Survival Rates for Out-of-Hospital Cardiac Arrest (OHCA) at Emergency Medical Service (EMS) Agencies With Catchment Areas With Primarily Black and Hispanic Populations Compared With Catchment Areas With Primarily White Populations




Rates of risk-standardized survival for OHCA are compared between EMS agencies serving primarily Black and Hispanic populations (>50% of residents) and agencies serving primarily White populations (>50% of residents).

## Results

Among 764 EMS agencies, 82 (10.7%) served a primarily Black and Hispanic catchment area and 682 (89.3%) served a primarily White catchment area (eFigure 3 in Supplement 1). For EMS agencies serving Black and Hispanic catchment areas, the proportion of residents who were Black or Hispanic ranged from 50.1% to 94.8%, with a median of 63.5% (IQR, 56.7%-71.6%). Median OHCA case volume during the study period among all EMS agencies was 125 (IQR, 59-290) and was higher for EMS agencies serving Black and Hispanic catchment areas (median, 247; IQR, 76-913) compared with White catchment areas (median, 117; IQR, 58-253). Patient characteristics by an EMS agency's catchment area are summarized in **Table 1.** Overall median age of the patients was 63.0 (IQR, 52.0-75.0) years, 36.1% were women, and 63.9% were men. Among patients with race and ethnicity data in CARES, 26.6% were Black and 7.7% were Hispanic. Most OHCAs occurred at home (82.3%), were of a presumed cardiac source (85.0%), and had an initially detected rhythm that was nonshockable (79.1%). Patients who experienced OHCA at EMS agencies with Black and Hispanic catchment areas were more likely to be of Black race or Hispanic ethnicity than White (63.5% vs 20.6%), have an unwitnessed arrest (59.5% vs 54.6%), and have asystole as the initially detected rhythm (55.5% vs 49.9%). Additionally, patients with OHCA at EMS agencies with Black and Hispanic compared with White catchment areas were younger (median age, 62.0 vs 64.0 years) and were less likely to receive bystander CPR (33.0% vs 41.6%) or have ventricular fibrillation as the initially detected rhythm (12.1% vs 16.4%).

After adjusting for patient and arrest characteristics, the mean (SD) RSSR to hospital admission was 27.5% (3.6%) and ranged from 16.6% to 43.4% (eFigure 4 in Supplement 1). Notably, EMS agencies with Black and Hispanic catchment areas had lower survival rates for OHCA by a mean of 1.9% compared with EMS agencies with White catchment areas (mean [SD], Black and Hispanic: 25.8% [3.6%] compared with White: 27.7% [3.5%]; $P < .001$) (**Figure, Table 2**). When stratified by survival quartiles for OHCA, a disproportionately higher number (32 [39.0%]) of EMS agencies serving Black and Hispanic catchment areas were in the lowest survival quartile, whereas a lower number (12 [14.6%]) were in the highest survival quartile (**Table 3**). The impact of this distribution at the patient level is reported in eTable 2 in Supplement 1.

**Table 4** summarizes the available EMS agency-level and first responder metrics among the agencies. The EMS agencies serving Black and Hispanic catchment areas had similar response times as those serving White catchment areas but had lower rates of TOR for OHCAs that met futility criteria as well as those that did not meet futility criteria for TOR. Rates of first responder initiation of CPR did not differ significantly between EMS agencies with Black and Hispanic compared with White catchment areas, but EMS agencies working in White catchment areas had a higher proportion of OHCAs in which first responders first applied an AED (Table 4). Additional adjustment for these EMS and first responder metrics, however, did not meaningfully attenuate differences in OHCA survival between EMS agencies with Black and Hispanic compared with White catchment areas (mean [SD] RSSRs after adjustment, 25.9% [3.3%] vs 27.7% [3.1%]; $P < .001$) (Table 2).

## Discussion

Given the central importance of EMS agencies in providing prehospital care, we examined prehospital survival for OHCA at EMS agencies serving Black and Hispanic catchment areas to better understand potential reasons for racial and ethnic disparities in OHCA survival. We found that EMS agencies serving Black and Hispanic catchment areas had lower rates of OHCA survival compared with EMS agencies serving White catchment areas. The absolute difference of 1.9%, while small to modest, is important, as it reflects a difference in survival. Adjustment for several EMS agency and first responder metrics did not meaningfully attenuate the survival difference between these 2 EMS agency groups. Our findings suggest that other factors related to the resuscitation response likely account for the lower OHCA survival rate at EMS agencies serving Black and Hispanic catchment areas and that additional research is needed to identify barriers and challenges to resuscitation care at these agencies to improve equity in OHCA outcomes.

Prior studies have reported racial and ethnic differences in OHCA care or survival by census tract or other geographic regions.[2-5] Our findings extend these earlier findings in several important ways. First, we examined racial and ethnic differences in OHCA survival by an EMS agency's catchment area. We focused our analysis at the EMS agency level because, unlike geographic areas, EMS agencies have an identifiable resuscitation infrastructure and leadership to support quality improvement efforts. Second, we evaluated the extent to which available EMS agency and first

Table 2. OHCA Survival by EMS Agency Type

| Variable | All EMS agencies (N = 764) | Agencies with Black and Hispanic catchment area (n = 82)[a] | Agencies with White catchment area (n = 682)[b] | *P* value |
|---|---|---|---|---|
| **Risk-standardized survival rate[c,d]** | | | | |
| Mean (SD), % | 27.5 (3.6) | 25.8 (3.6) | 27.7 (3.5) | <.001 |
| Median (IQR), % | 27.4 (25.1-29.6) | 25.7 (23.5-28.2) | 27.5 (25.3-29.7) | |
| **With adjustment for EMS metrics[e]** | | | | |
| Mean (SD), % | 27.5 (3.2) | 26.0 (3.4) | 27.7 ( 3.2) | <.001 |
| Median (IQR), % | 27.2 (25.4-29.4) | 25.9 (23.3-28.5) | 27.3 (25.6-29.5) | |
| **Additional adjustment for first responder metrics[f]** | | | | |
| Mean (SD), % | 27.5 (3.2) | 25.9 (3.3) | 27.7 (3.1) | <.001 |
| Median (IQR), % | 27.1 (25.5-29.2) | 25.9 (23.3-28.6) | 27.2 (25.6-29.4) | |

Abbreviations: EMS, emergency medical service; OHCA, out-of-hospital cardiac arrest.

[a] Catchment areas with primarily Black and Hispanic populations (>50% of residents).

[b] Catchment areas with primarily White populations (>50% of residents).

[c] Analysis of OHCA survival was risk standardized for EMS agencies and was adjusted for age, sex, bystander cardiopulmonary resuscitation (CPR), witnessed status, initial arrest rhythm, location and cause of arrest, and urbanicity.

[d] Risk-standardized survival rates to hospital admission for OHCA were lower at EMS agencies serving Black and Hispanic catchment areas compared with agencies serving White catchment areas. Adjustment for 3 EMS and 2 first responder metrics did not meaningfully attenuate lower OHCA survival at EMS agencies serving Black and Hispanic catchment areas.

[e] Additionally adjusted for EMS agency response times, termination of resuscitation (TOR) rates without meeting futility criteria, and TOR rates when futility criteria were met.

[f] Additionally adjusted for percentage of OHCA cases in which CPR was initiated by first responders before EMS arrival and percentage of cases in which an automated external defibrillator was first applied by a first responder.

Table 3. Distribution of EMS Agencies Across Quartiles of Risk-Standardized Survival

| Catchment area category | Quartile of OHCA survival[a] | | | | Total |
|---|---|---|---|---|---|
| | Quartile 1 (16.6%-25.0%) | Quartile 2 (25.1%-27.3%) | Quartile 3 (27.4%-29.5%) | Quartile 4 (29.6%-43.4%) | |
| No. of EMS agencies | 191 | 191 | 191 | 191 | 764 |
| Black and Hispanic, No, (%) | 32 (39.0) | 24 (29.3) | 14 (17.1) | 12 (14.6) | 82 |
| White, No. (%) | 159 (23.3) | 167 (24.5) | 177 (26.0) | 179 (26.2) | 682 |

Abbreviations: EMS, emergency medical service; OHCA, out-of-hospital cardiac arrest.

[a] Survival of OHCA was risk standardized for EMS agencies and was adjusted for age, sex, bystander cardiopulmonary resuscitation, witnessed status, initial arrest rhythm, location and cause of arrest, and urbanicity.

Table 4. EMS Agency and First Responder Metrics

| Metric | Total (N = 764) | Black and Hispanic catchment area (n = 82)[a] | White catchment area (n = 682)[b] | *P* value |
|---|---|---|---|---|
| EMS metrics | | | | |
| Time from call to EMS arrival, median (IQR), min | 9.6 (8.1-11.5) | 9.6 (8.4-11.1) | 9.7 (8.1-11.6) | .82 |
| TOR rates when meeting futility criteria, median (IQR), % | 15.7 (9.6-21.4) | 12.6 (4.3-22.0) | 15.8 (10.0-21.2) | .04 |
| TOR rates when not meeting futility criteria, median (IQR), % | 21.8 (11.1-32.4) | 11.3 (3.1-26.2) | 22.9 (13.0-33.1) | <.001 |
| First responder metrics | | | | |
| CPR initiated by first responder, median (IQR), % | 54.5 (31.6-71.4) | 54.4 (33.8-68.7) | 54.5 (31.6-71.9) | .67 |
| AED applied by first responder, median (IQR), % | 23.6 (8.9-41.5) | 20.8 (4.7-32.5) | 24.5 (9.3-43.5) | .003 |

Abbreviations: AED, automated external defibrillator; CPR, cardiopulmonary resuscitation; EMS, emergency medical service; TOR, termination of resuscitation.

[a] Catchment areas with primarily Black and Hispanic populations (>50% of residents).

[b] Catchment areas with primarily White populations (>50% of residents).

responder metrics in an OHCA registry accounted for lower OHCA survival at EMS agencies with Black and Hispanic catchment areas. We found no significant difference in EMS response times and that EMS agencies with Black and Hispanic catchment areas actually had lower rates of TOR regardless of whether futility criteria were met, making these factors unlikely targets for reducing disparities. While EMS agencies working in White catchment areas had higher rates of first responder application of AEDs, accounting for this difference did not attenuate survival differences, probably because most OHCAs have an initially nonshockable cardiac arrest rhythm.

Our findings suggest that other unmeasured factors may account for lower OHCA survival at EMS agencies serving Black and

Hispanic catchment areas. Illuminating these factors, including unique challenges and barriers to resuscitation care, may help address disparities in OHCA survival and ensure health care equity. Black and Hispanic communities have unique challenges for prehospital care that are not present in White communities. Black and Hispanic residents may be more reluctant to activate 911 if they perceive police and dispatchers to be untrustworthy or fear deportation because of their immigration status, potentially limiting the benefits of dispatcher-assisted CPR.[18,19] Structural racism may have led to unequal investments in resuscitation infrastructure and contributed to lower survival rates in Black and Hispanic communities. For instance, layperson CPR training is offered less frequently in Black communities,[20] and availability of AEDs may be scant, leading to markedly lower rates of potentially life-saving bystander interventions. Similarly, EMS agencies serving Black or Hispanic catchment areas may have limited resources for quality improvement, lower training rates in AED use for first responders (eg, police), and concerns about public safety during OHCA response.

Efforts to identify barriers to resuscitation care at EMS agencies serving Black and Hispanic catchment areas will likely require a mixed-methods research approach at EMS agencies, akin to previous mixed-methods research focused on identifying best practices at hospitals with high survival rates for in-hospital cardiac arrest[21,22] and shorter door-to-balloon times for ST-elevation myocardial infarction.[23-25] A detailed survey of resuscitation training, policies, and practices at EMS agencies that is linked to agency-level survival outcomes could provide important insights into key barriers and challenges at agencies serving Black and Hispanic catchment areas as well as best resuscitation strategies used by top-performing agencies. On-site qualitative interviews at EMS agencies with Black and Hispanic catchment areas that are top and bottom performers in OHCA survival could provide additional insights into barriers to delivering resuscitation care in these communities, as well as best practices and processes to overcome such barriers (eg, novel collaborations between EMS and first responders [fire and police] and strong relationships with community members). In our study, we identified 12 EMS agencies serving Black and Hispanic catchment areas in the highest quartile of OHCA survival, and these agencies could form the foundation for future qualitative research to understand how they achieved high prehospital survival rates for OHCA in their communities.

### Limitations

Our study should be interpreted in the context of the following limitations. CARES is a voluntary registry and has a current catchment area of over half of US residents. Our findings may not be generalizable to EMS agencies with low OHCA volumes (eg, rural areas, as reporting sites in CARES skew toward urban areas). Second, patient comorbidities are not systematically collected in CARES. It is possible that OHCA individuals in Black and Hispanic communities have more comorbidities than those in White communities, which could partly explain why EMS agencies with Black and Hispanic catchment areas had lower survival rates for OHCA. Third, we had limited data in CARES on other EMS agency factors or metrics for evaluation. Fourth, we did not have detailed data on other first responder interventions, training and experience of EMS personnel, and EMS agency resuscitation policies, nor did we have information on leadership culture at EMS agencies, highlighting the need for a systematic mixed-methods approach to identify unique barriers and challenges at EMS agencies with Black and Hispanic catchment areas, as well as best resuscitation practices at top-performing agencies.

## Conclusions

In this cohort study, RSSRs for OHCA were 1.9% lower at EMS agencies working in majority Black and Hispanic catchment areas than in majority White catchment areas. This difference was not explained by EMS response times, rates of EMS TOR, or first responder rates of initiating CPR or applying an AED. Additional research using patient-level data is needed to assess whether there are barriers and challenges to resuscitation care in areas serving Black and Hispanic communities, such as bystander response or community resources.

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