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Clinical paper

Racial and ethnic differences in outcomes after out-of-hospital cardiac arrest: Hispanics and Blacks may fare worse than non-Hispanic Whites

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Abstract

Background: This study evaluates differences in out-of-hospital cardiac arrest (OHCA) characteristics, interventions, and outcomes by race/ethnicity.

Methods: This is a retrospective analysis from a regionalized cardiac system. Outcomes for all adult patients treated for OHCA with return of spontaneous circulation (ROSC) were identified from 2011–2014. Stratifying by race/ethnicity with White as the reference group, patient characteristics, treatment, and outcomes were evaluated. The adjusted odds ratios (OR) for survival with good neurologic outcome (cerebral performance category 1 or 2) were calculated.

Results: There were 5178 patients with OHCA; 290 patients excluded for unknown race, leaving 4888 patients: 50% White, 14% Black, 12% Asian, 23% Hispanic. In univariate analysis, compared with Whites, Blacks had fewer witnessed arrests (83% vs 86%, $p = 0.03$) and less bystander CPR (37% vs 44%, $p = 0.005$), were less likely to undergo coronary angiography (14% vs 22%, $p < 0.0001$), and less likely to receive PCI (32% vs 54%, $p < 0.0001$). Asians presented less often with a shockable rhythm (27% vs 34%, $p = 0.001$) and were less likely to undergo angiography (15% vs 22%, $p < 0.0001$). Hispanics presented less often with a shockable rhythm (31% vs 34%, $p = 0.03$), had fewer witnessed arrests (82% vs 86%, $p = 0.001$) and less bystander CPR (37% vs 44%, $p = 0.0001$). In multivariable analysis, Hispanic ethnicity was associated with decreased favorable neurologic outcome (OR 0.78 [95%CI 0.63–0.96]). Outcomes for Asians and Blacks did not differ from Whites. When accounting for clustering by hospital, race was no longer statistically significantly associated with survival with good neurologic outcome.

Conclusion: We identified important differences in patients with OHCA according to race/ethnicity. Such differences may have implications for interventions; for example, emphasis on bystander CPR instruction in Black and Hispanic communities.

Keywords: Cardiopulmonary arrest, Race, Ethnicity

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Introduction

Out-of-hospital cardiac arrest (OHCA) is a major public health problem affecting approximately 300,000 people in the United States each year.[1] Multiple prior studies demonstrate differences in survival from both in-hospital[2,3] and out-of-hospital[4–6] cardiac arrest according to race or ethnicity. However, not all studies have confirmed these differences. Researchers in King County, Washington[7] and in urban-suburban regions in Michigan[8] found no association of race with outcome from OHCA in a risk-adjusted analysis. The majority of data evaluating racial differences in outcome after cardiac arrest focuses on comparison of Blacks and Whites; there is a paucity of data on comparative outcomes for other racial or ethnic groups.[6] Research is needed to further characterize the observed differences across racial and ethnic groups, which can help inform targeted interventions for improvement. Some authors have found that accounting for differences in arrest characteristics and bystander CPR rates eliminates the observed differences in outcome.[9,10] Further, in the current era of post-resuscitation care, disparities in treatment may contribute to differences in outcome. Race has been found to be a predictor of delays to percutaneous coronary intervention (PCI) in patients with acute myocardial infarction.[11–13] The purpose of this study was to evaluate racial/ethnic differences in OHCA characteristics, interventions, and outcomes, including survival to hospital discharge and survival with good neurologic outcome, in a diverse metropolitan area with a regional cardiac care system.

Methods

This is a retrospective study of registry data from the Los Angeles (LA) County Emergency Medical Services (EMS) system. The study was reviewed and approved with exemption of informed consent by the Research and Education Institute at Harbor-UCLA institutional review board.

LA County is a large metropolis, comprising 88 cities spanning over 4000 square miles with a population of 10.2 million. The population of LA County is diverse with approximately 28% non-Hispanic White, 9% Black, 14% Asian, 49% Hispanic, and $<1\%$ American Indian and Hawaiian or Pacific Islander. LA County EMS operates a regional cardiac system of care for patients with ST elevation myocardial infarction (STEMI) and/or OHCA that has been previously described.[14,15] EMS providers transport patients resuscitated from OHCA to one of 35 designated cardiac arrest receiving centers. These centers are capable of providing immediate coronary angiography and primary PCI 24 h per day, 7 days per week and have cardiovascular surgeons available. In addition, all centers are required to have a robust quality improvement program and internal policies for PCI, fibrinolysis, and targeted temperature management (TTM). Cardiac arrest receiving centers submit data on all adult patients with return of spontaneous circulation (ROSC) after OHCA to a single registry maintained by the LA County EMS Agency. Data abstraction from prehospital and hospital records is completed by registered nurses (RN) in the departments of emergency medicine or cardiology, or by quality improvement staff. Completeness and accuracy of the entered data are reviewed by the EMS Agency with verification performed during site visits.

The database was queried from 2011 through 2014 for all adult patients with OHCA. Study variables included age, gender, race/ethnicity, initial cardiac rhythm, arrest location, witness, bystander cardiopulmonary resuscitation (CPR), bystander automated external defibrillator (AED) use, ECG findings (STEMI or no STEMI), length of stay, induction of TTM, and whether the patient received coronary angiography and PCI. STEMI was indicated in the database if STEMI was identified on the ECG, either in the field by software interpretation or in the emergency department by physician interpretation. Race and ethnicity are obtained from self-reported registration data in hospital records. Categories in the database include non-Hispanic White, non-Hispanic Black, Hispanic/Latino, Asian, Pacific Islander/Native Hawaiian, and other.

The primary outcome of the study was survival to hospital discharge with good neurologic outcome, as defined by a Cerebral Performance Category (CPC) score at hospital discharge of 1 or 2. A CPC of 1 corresponds to a return to normal or mildly impaired cerebral function and independence with activities of daily living. A CPC of 2 corresponds to moderate cerebral disability but sufficient function to remain independent with activities of daily living. CPC scores documented by physician, nurse or occupational therapy assessment at the time of discharge were abstracted from the medical record and recorded in the database.

All data were entered into Microsoft Excel (Microsoft Corporation, Redmond WA) and transferred to SAS 9.4 (SAS Institute, Cary, NC) for analysis. The patient characteristics, interventions, and outcomes were evaluated by race and ethnicity and these univariate data are reported as proportions with risk differences (RD) and exact binomial confidence intervals. For the primary outcome of neurologically intact survival, adjusted OR and their p-values were calculated using logistic regression and the Chi-square test. Designating White as the reference group, the adjusted odds ratio (OR) for survival with good neurologic outcome was calculated for each race/ethnicity classification. Patient characteristics (age, gender), arrest characteristics (initial rhythm, witness, bystander CPR), and interventions (coronary angiography, PCI, and TTM), were included in the multivariable regression based upon prior knowledge of their contribution to cardiac arrest outcomes. An additional model, adjusted for fixed characteristics alone (patient age, gender, initial rhythm and witnessed arrest) was performed to assess the impact of fixed versus modifiable criteria. Further, anticipating correlation of outcomes within hospitals, we performed an analysis with the fully adjusted multivariable regression accounting for clustering by hospital with generalized estimating equations (GEE) using the *proc genmod* option in SAS 9.4. We used the "exchangeable" covariance structure for the GEE analysis. Regression analysis was limited to subjects with complete data. Model fit was determined by assessing the Hosmer-Lemeshow fit statistic.

Results

There were 5178 patients with OHCA; 290 patients were excluded for other (205) or unknown (85) race, leaving 4888 patients of whom 50% were White, 14% Black, 12% Asian, 23% Hispanic, and 0.8% Pacific Islander.

In the univariate analysis, there were several differences between groups. Compared with Whites, Blacks had fewer witnessed arrests (83% vs 86%, $p=0.03$) and less bystander CPR (37% vs 44%, $p=0.005$). In addition, Blacks were less likely to undergo coronary angiography (14% vs 22%, $p<0.0001$) but also less likely to receive PCI when coronary angiography was performed (32% vs 54%,

$p < 0.0001$). Asians presented less often with a shockable rhythm (27% vs 34%, $p = 0.001$), were less likely to undergo angiography (15% vs 22%, $p < 0.0001$), had lower survival to hospital discharge (32% vs 37%, $p = 0.02$), and lower survival with good neurologic outcome (17% vs 24%, $p = 0.001$). Hispanic patients presented less often with shockable rhythm (31% vs 34%, $p = 0.03$), had fewer witnessed arrests (82% vs 86%, $p = 0.001$), less bystander CPR (37% vs 44%, $p = 0.0001$), and lower survival with good neurologic outcome (21% vs 24%, $p = 0.05$). Comparisons with risk differences are shown in Table 1.

For main outcomes determined by the multivariable analyses, Table 2 shows the adjusted OR for survival with good neurologic outcome by race and ethnicity, adjusting for fixed patient and arrest characteristics only (age, gender, initial rhythm and witnessed arrest). Table 3 describes the adjusted OR for survival with good neurologic outcome after adjusting for age, gender, arrest characteristics and hospital interventions. In both models, Hispanic ethnicity was associated with decreased favorable neurologic outcome, OR 0.75 (95%CI 0.61–0.93) and OR 0.78 (95%CI 0.63–0.96) respectively. This was also the case for Asians when adjusting for fixed characteristics alone, OR 0.73 (95%CI 0.56–0.97) although this was no longer statistically significant after adjustment for modifiable factors including bystander CPR and hospital interventions, OR 0.79 (95%CI 0.60–1.05). Outcomes for Blacks were similar to Whites in both models, OR 0.87 (95%CI 0.68–1.11) and OR 0.98 (95%CI 0.76–1.25) respectively. In the regression model accounting for clustering by hospital, race was no longer statistically significantly associated with survival with good neurologic outcome, OR 0.95 (95%CI 0.89–1.01).

Table 2 – Adjusted odds ratios for survival to hospital discharge with good neurologic outcome by race/ethnicity, adjusted for patient factors and unmodifiable arrest factors. (N = 4457).

	AOR[a] (95% CI)	
White	Ref	Ref
Asian	0.73	(0.56–0.97)
Black	0.87	(0.68–1.11)
Hispanic	0.75	(0.61–0.93)
Pacific Islander	0.73	(0.30–1.81)

[a] AOR = Adjusted odds ratio ; Adjusted for patient factors (age and gender) and unmodifiable arrest factors (initial shockable rhythm, witnessed arrest). Hosmer–Lemeshow fit statistic p = 0.07.

Discussion

In this diverse metropolitan regionalized system of care, we found important differences in cardiac arrest outcomes according to race and ethnicity. Notably, when compared to Whites, after controlling for all available characteristics known to affect outcomes from OHCA, Hispanics were less likely to survive with good neurologic outcome.

Table 1 – Characteristics, treatment and outcome of OHCA by race/ethnicity.

	White (2441)[a]		Black (683)			Asian (605)			Hispanic (1122)		
	N	%	N	%	RD (95%CI)	N	%	RD (95%CI)	N	%	RD (95%CI)
Patient characteristics											
Gender											
Male	1480	61	330	48	−13% (−17, −9%)	391	64	3% (−1, 7%)	680	61	0% (−3, 3%)
Female	960	39	353	52	13% (9, 17%)	214	35	−4% (−8, 0.3%)	442	39	0% (−3, 3%)
Age in years (median/IQR)	69	(58–81)	66	(56–77)	ns	73	(59–84)	ns	65	(54–76)	ns
Arrest characteristics											
Initial shockable rhythm	775	34	199	31	−3% (−7, 1%)	151	27	−7% (−11, −3%)	320	31	−3% (−6, −0.3%)
Witnessed arrest	2040	86	552	83	−3% (−6, 0.1%)	488	83	−3% (−6, 0.3%)	883	82	−4% (−7, −1%)
Bystander CPR	1048	44	253	37	−7% (−11, −3%)	246	41	−3% (−7 ,1%)	406	37	−7% (−10, −4%)
Bystander AED	65	3	15	2	−0.5% (−2, 1%)	19	3	0.5% (−1, 2%)	19	2	−1% (−2, 0%)
STEMI	712	29	180	26	−3% (−7, 1%)	163	27	−2% (−6, 2%)	339	30	1% (−2, 4%)
Hospital interventions											
Coronary angiography	538	22	95	14	−8% (−11, −5%)	91	15	−7% (−10, −4%)	239	21	−1% (−4, 2%)
PCI (% of catheterizations)	288	54	30	32	−22% (−32, −12%)	46	51	−3% (−14, 8%)	130	54	0% (−8, 8%)
D2B in min (median/IQR)	78	(60–103)	80	(58–109)	ns	80	(60–99)	ns	80	(56–103)	ns
TTM	895	37	283	42	5% (1, 9%)	206	34	−3% (−7, 1%)	441	40	3% (−0.4, 6%)
Patient outcomes											
SHD	892	37	275	40	3% (−1, 7%)	192	32	−5% (−9, −1%)	380	34	−3% (−6, 0.4%)
CPC 1–2	543	24	139	21	−3% (−6, 0.5%)	102	17	−7% (−10, −4%)	224	21	−3% (−6, 0%)

RD = Risk difference; IQR = Inter-quartile range; CPR = Cardiopulmonary resuscitation; AED = Automated external defibrillator; PCI = Percutaneous coronary intervention; D2B = Door-to-balloon time; TTM = Targeted temperature management; SHD = Survival to hospital discharge; CPC = cerebral performance category.
[a] Reference group. Pacific Islanders (N = 37) not shown.

Table 3 – Adjusted odds ratios for survival to hospital discharge with good neurologic outcome by race/ethnicity, adjusted for patient factors, arrest factors, and in-hospital treatment. (N = 4412).

	AOR[a] (95% CI)	
White	Ref	Ref
Asian	0.79	(0.60–1.05)
Black	0.98	(0.76–1.25)
Hispanic	0.77	(0.63–0.96)
Pacific Islander	0.82	(0.33–2.01)

[a] AOR = Adjusted odds ratio ; Adjusted for patient factors (age and gender), arrest factors (initial shockable rhythm, witnessed arrest, bystander CPR) and treatment (emergent coronary angiography, percutaneous coronary intervention, and targeted temperature management). Hosmer–Lemeshow fit statistic p = 0.15.

This difference in outcome by race/ethnicity was no longer statistically significant after adjusting for clustering by hospital. Thus, one consideration is that the differences in outcomes relate to in-hospital treatment, which broadly includes such factors as whether the hospital is a tertiary care center, or a public or private hospital, whether there are trainees, and the annual volume of cardiac arrest patients treated. Racial disparities in treatment after OHCA have been demonstrated in prior studies.[16–18] Chan et al. found that adjustment for hospital center accounted for the majority of observed racial outcome difference in their cohort of in-hospital cardiac arrest patients,[2] though there remained an association of race with outcome even after adjusting for hospital center. Since Hispanics fared worse than Whites even after adjustment for patient and arrest characteristics as well as for hospital interventions, it is unlikely that our findings in this cohort of patients with OHCA are due to differences hospital treatment alone.

The difference in outcomes may be due to differences in community response. Similar to a prior study by Benson et al. in the city of Los Angeles, we found a lower rate of bystander CPR among Hispanics compared with Whites.[19] This is also consistent with national data.[1,20] Using The Cardiac Arrest Registry to Enhance Survival (CARES), Sasson et al. demonstrated an association between neighborhood and bystander CPR; notably patients with OHCA in lower income neighborhoods and minority neighborhoods were less likely to receive bystander CPR.[20] Blacks and Hispanics were approximately 30% less likely to receive bystander CPR compared to Whites.[20] Our data set does not contain the patient's address or arrest location. However, adjustment for correlation of outcomes by treating hospital may be accounting, at least in part, for the community it serves. Therefore, the lack of racial difference in outcome after adjustment by hospital, along with the observed differences in bystander CPR rates, is consistent with possible differences in community response. In subsequent work, Sasson et al. identified multiple barriers to activating emergency response in a Hispanic community in Denver, as well as cultural barriers to performing bystander CPR.[21] Our data further supports that barriers may exist in the Hispanic community with respect to rapid alert and bystander CPR, two critical links in the chain of survival after OHCA. Another important component of the chain of survival is defibrillation. A recently published study by Owen et al. found that Hispanics were also less likely to be trained in AED use compared with Whites and Blacks.[22] While our cohort had low rates of AED use across all groups, Hispanics trended towards decreased use compared with Whites, though this did not reach statistical signifiance. Our data do not include information regarding co-morbidities, which may also contribute to the observed differences in outcomes. Sargsyan et al. found significant differences in co-morbidities among Hispanics with OHCA compared to Whites.[23]

Unlike some prior studies[4–6,24], we did not find worse outcomes in Blacks compared with Whites. However, similar to prior studies, we found lower rates of witnessed arrest and bystander CPR among Blacks as compared to Whites.[4,5,9,25] As with Hispanics, prior authors have postulated that these differences could contribute the observed worse outcomes. In our cohort, the lack of difference in outcome between Blacks and Whites may be due to a limitation of sample size. However, other more contemporary studies report similar findings to ours.[7,10] Galea et al. noted an age-adjusted mortality increase among Blacks compared to Whites. However, once adjusting for other patient and arrest characteristics, this difference was eliminated.[10] Chan et al. found lower rates of survival among Blacks with in-hospital cardiac arrest, though much of the difference was attributable to the hospital at which the patient received care.[2] More recently, in a study of temporal changes in cardiac arrest outcomes over a period of 15 years, Joseph et al. found that the outcome disparity after in-hospital cardiac arrest between Blacks and Whites has narrowed over time.[26] Several studies have suggested that differences in socioeconomic status may contribute to the observed racial differences.[5,9] Still, it is not clear why we did not find worse outcome in Blacks, even prior to accounting for treatment hospital, despite seemingly similar potential community barriers to Hispanics. There may be other unmeasured differences between the groups that we are unable to determine with our data.

Although Asians presented less often with ventricular fibrillation as the initial rhythm and were less likely to receive coronary angiography when compared with Whites, after accounting for these differences, we did not find a difference in outcome. Asians also had similar rates of bystander CPR and witnessed arrest when compared with Whites.

Despite similar outcomes in Whites, Blacks and Asians, we observed a decreased frequency of in-hospital interventions in minority groups, in particular in Blacks and Asians, including coronary angiography and percutaneous coronary intervention. The frequency of TTM was not lower in minorities. Other authors have noted disparities in interventions over time in patients post cardiac arrest. Groenevold et al. reported that Blacks were less likely to receive an implantable cardiac defibrillator (ICD) or revascularization after cardiac arrest despite evidence that ICD implantation benefits Blacks and Whites equally.[16] Lower rates of cardiac procedures could explain lower survival rates among Black patients.[16]

Our data support prior studies, which suggest that community and cultural factors may contribute to OHCA survival. In particular, Blacks and Hispanics were less likely to receive bystander CPR, and Hispanics were less likely to survive with good neurologic outcome. The first step is identifying the outcome disparities. Next, one must explore potential causes, develop an intervention and measure improvement. As has been highlighted by prior authors, it is important to account for cultural differences when developing public education and training in OHCA response and bystander CPR. Sasson et al. identified specific interventions that could improve bystander CPR rates in Hispanic communities including: education in Spanish, increasing availability of bilingual 9-1-1 dispatchers, and policy level changes to enhance requirements for bystander CPR education and strengthen Good Samaritan laws.[21] Culturally sensitive targeted interventions in Hispanic communities may improve survival in these patients.

Several limitations must be considered when interpreting our findings. Given the retrospective study design, we cannot determine causality and the frequency of interventions is subject to selection bias. Our analysis is not inclusive of all patients with cardiac arrest in LA County; the registry includes patients with OHCA who achieve ROSC, at least transiently, and are treated at a cardiac arrest receiving center. This likely explains the higher proportion of witnessed arrests and initial shockable rhythm compared with national studies. Patients who were not transported (met field termination of resuscitation criteria) and patients transported to a hospital other than a cardiac arrest receiving center were not included in this analysis. We were unable to include adjustment for downtime, as this data were missing in the majority of patients and are likely to be inaccurate when reported.[27,28] By limiting analysis to complete subjects, we make the assumption that the data are missing at random, which if untrue, can lead to bias or incomplete control of confounders. However, since values were missing less than 10% of the time, we believe that imputation or other means of adjusting for missing values would not make a substantive difference in the results. In addition, given the retrospective methodology, there are other potential unknown and unmeasured confounders. Specifically, the database does not include information on comorbid conditions, arrest aetiology, socioeconomic status and other risk factors that may differ between patients of different race and ethnicity presenting with OHCA. These factors could not be accounted for in this analysis and causality cannot be determined. Given the multiple comparisons and multiple testing, it is possible that some of the differences, although statistically significant, may still be due to chance alone. Finally, as the Hispanic population represents the largest minority group in LA County, it is possible that low sample size may have contributed to the lack of difference in outcomes detected in other minority groups as compared to Whites.

Conclusion

We identified important differences in characteristics and outcomes of patients with OHCA according to race/ethnicity. While further study to define the cause of such differences is warranted, targeted interventions, for example, bystander CPR instruction in Black and Hispanic communities, may improve outcomes.

Conflict of interest statement

None.

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