Available online at www.sciencedirect.com

Resuscitation

journal homepage: www.elsevier.com/locate/resuscitation

Clinical paper

Racial disparities in out-of-hospital cardiac arrest interventions and survival in the Pragmatic Airway Resuscitation Trial☆

Joshua R. Lupton[a,*], *Robert H. Schmicker*[b], *Tom P. Aufderheide*[c], *Audrey Blewer*[d], *Clifton Callaway*[e], *Jestin N. Carlson*[f], *M. Riccardo Colella*[c], *Matt Hansen*[a], *Heather Herren*[b], *Graham Nichol*[b], *Henry Wang*[g], *Mohamud R. Daya*[a]

[a] *Oregon Health & Science University, United States*
[b] *University of Washington School of Medicine, United States*
[c] *Medical College of Wisconsin, United States*
[d] *Duke University School of Medicine, United States*
[e] *University of Pittsburgh School of Medicine, United States*
[f] *Allegheny Health Network, United States*
[g] *University of Texas Health Science Center at Houston, United States*

Abstract

Background: Prior studies have reported racial disparities in survival from out-of-hospital cardiac arrest (OHCA). However, these studies did not evaluate the association of race with OHCA course of care and outcomes. The purpose of this study was to evaluate racial disparities in OHCA airway placement success and patient outcomes in the multicenter Pragmatic Airway Resuscitation Trial (PART).

Method: We conducted a secondary analysis of adult OHCA patients enrolled in PART. The parent trial randomized subjects to initial advanced airway management with laryngeal tube or endotracheal intubation. For this analysis, the primary independent variable was patient race categorized by emergency medical services (EMS) as white, black, Hispanic, other, and unknown. We used general estimating equations to examine the association of race with airway attempt success, 72-h survival, and survival to hospital discharge, adjusting for sex, age, witness status, bystander cardiopulmonary resuscitation (CPR), initial rhythm, arrest location, and PART randomization cluster.

Results: Of 3002 patients, EMS-assessed race as 1537 white, 860 black, 163 Hispanic, 90 other, and 352 unknown. Initial shockable rhythms (13.8% vs. 21.5%, $p < 0.001$), bystander CPR (35.6% vs. 51.4%, $p < 0.001$), and survival to hospital discharge (7.6% vs. 10.8%, $p = 0.011$) were lower for black compared to white patients. After adjustment for confounders, no difference was seen in airway success, 72-h survival, and survival to hospital discharge by race.

Conclusions: In one of the largest studies evaluating differences in prehospital airway interventions and outcomes by EMS-assessed race for OHCA patients, we found no significant adjusted differences between airway success or survival outcomes.

Keywords: Out-of-hospital cardiac arrest, Cardiac arrest, Airway, Race, Disparities, Emergency medical services

☆ Abstract of these results were presented at the American Heart Association Resuscitation Science Symposium meeting on November 16, 2019 (Philadelphia, PA) and at the National Association of EMS Physicians meeting on January 10th, 2020 (San Diego, CA).

* Corresponding author at: Department of Emergency Medicine, Center for Policy and Research in Emergency Medicine, Oregon Health & Science University, 3181 SW Sam Jackson Park Road, Portland, OR 97239-3098, United States.
E-mail address: lupton@ohsu.edu (J.R. Lupton).

https://doi.org/10.1016/j.resuscitation.2020.08.004
Received 13 May 2020; Received in revised form 24 July 2020; Accepted 3 August 2020
0300-9572/© 2020 Elsevier B.V. All rights reserved.

Introduction

Out-of-hospital cardiac arrest (OHCA) remains a significant cause of morbidity and mortality in the United States.[1] Evidence suggests that survival from OHCA is worse for black and Hispanic patients compared to white patients.[2–7] Part of this disparity in survival may be due to lower rates of bystander cardiopulmonary resuscitation (CPR), witnessed arrests, and initial shockable rhythms,[7–10] all differences that may be attributable to socioeconomic disparities. However, it is also important to consider bias of treating personnel as a potential factor for these differing outcomes.

Implicit bias, also known as unconscious bias, represents alterations in how someone thinks and reacts without overt or explicit awareness that they are doing so. This type of bias is present even in split-second decisions, and since the person possessing the bias remains unaware, it may be more pervasive and covert than explicit bias. In studies of health care professionals, provider implicit biases are broadly present in favor of white patients.[11,12] Implicit biases may also affect how providers react to patients in the emergency care context. Understanding whether clinical interventions by EMS providers and patient outcomes vary by patient race may inform future studies and methods to address racial disparities.

Prehospital interventions for OHCA include chest compressions, defibrillation, pharmacological therapies, and airway management. Despite the importance of airway management for OHCA, there are no studies examining racial differences in prehospital airway interventions. These critical interventions are time-sensitive and, in the stressful environment of an active cardiac arrest, providers may be susceptible to biases. The Pragmatic Airway Resuscitation Trial (PART) examined the effect of initial airway strategy comparing OHCA outcomes for laryngeal tube insertion (LT) with endotracheal intubation (ETI).[13] In this trial, detailed airway information including timing of airway attempt, success rates, and number of attempts was recorded in addition to perceived race by the prehospital team (EMS-assessed race). Our primary goal is to examine differences in airway success and patient outcomes by EMS-assessed race for adult OHCA patients.

Methods

Study design

We performed a secondary analysis of data from the Pragmatic Airway Resuscitation Trial. The Institutional Review Boards at the participating sites and institutions approved this protocol under federal rules for conduction of research under Exception From Informed Consent. This post-hoc analysis was planned after the primary results of PART were known and published.[13]

Study setting

PART included 27 EMS agencies in Birmingham (AL), Dallas-Fort Worth (TX), Milwaukee (WI), Pittsburgh (PA), and Portland (OR). The study was conducted from December 2015 through October 2017.

Patient population

PART included adults aged 18 years or older with non-traumatic out-of-hospital cardiac arrest treated by the participating EMS agencies listed above. Exclusion criteria included presence of a preexisting tracheostomy, do-not-resuscitate orders, an advanced airway established prior to EMS arrival, a left-ventricular assist device, a do-not-enroll bracelet, major bleeding, obvious asphyxial cause of arrest, interfacility transports, and traumatic etiology of arrest.

Intervention

The primary intervention for PART was an initial airway management strategy of laryngeal tube (LT) or endotracheal intubation (ETI). A subset of patients did not receive either of these interventions and had bag-valve-mask ventilation only (BVM-only).

Variables

Prehospital personnel recorded patient demographics including the patient age, sex (male or female), and race. Race was based on a check box and could include checking “unknown.” This was recorded in a single “race/ethnicity” section. For the purposes of this analysis, Hispanic was included as a race variable with black, white, other, and unknown. EMS providers rarely checked more than one race/ethnicity box. In seven instances of 3002 patients, EMS personnel checked Hispanic in addition to another “race/ethnicity” box, and for these patients they were grouped into the Hispanic category. In one other instance EMS personnel checked two “race/ethnicity” boxes, of which neither were Hispanic, and this individual was included in the “other” category. Arrest intervention details were collected from the prehospital medical record while hospital outcomes and additional demographic data were obtained from a review of hospital records for transported patients.

During PART, trained research assistants entered the variables into an electronic database and each site underwent periodic audits of data entry. Additionally, the data entry forms were constructed to have multiple integrated logic checks to assure higher-quality data.

Outcomes

The primary outcomes for this study were: prehospital airway success, 72-h survival, and survival to hospital discharge.

Statistical analysis

We used descriptive statistics to characterize the sample. We calculated the accuracy for EMS classified race via Kappa score by comparing EMS classified race to the hospital demographic information, limited to those transported and excluding those with race unknown. For the multivariable analyses, we used a generalized estimating equation (GEE) with a cluster term for the PART randomization clusters. The PART randomization clusters were stratified by site and included entire EMS agencies. Across the 5 sites there were 27 total agencies divided into 13 clusters, ranging from 2 to 4 clusters per site. There were two multivariable analyses performed. The first evaluated the association between race (categorical) and airway success (binary) adjusting for age, sex, type of airway attempted, and arriving service level. The second evaluated the association between race (white or black) and survival to 72-h controlling for age, sex, witnessed status, bystander CPR, initial rhythm, and arrest location. For this analysis, only white and black patients were compared due to insufficient numbers of patients with other EMS-assessed races and complete covariates. This second

Table 1 – Patient characteristics by EMS-assessed race (n = 3002).

	White	Black	Hispanic	Other	Unknown
n	1537	860	163	90	352
Age, median (IQR)[a]	65.0 (24.0)	62.0 (20.0)	59.0 (29.5)	65.0 (24.8)	65.0 (24.5)
Sex, male, n (%)[b]	979 (63.7%)	465 (54.1%)	104 (63.8%)	63 (70.0%)	218 (61.9%)
Initial rhythm, n (%)					
VT/VF	330 (21.5%)	119 (13.8%)	29 (17.8%)	19 (21.1%)	74 (21.0%)
PEA	308 (20.0%)	204 (23.7%)	28 (17.2%)	13 (14.4%)	63 (17.9%)
Asystole	716 (46.6%)	430 (50.0%)	89 (54.6%)	49 (54.4%)	160 (45.5%)
No shock advised[c]	141 (9.2%)	91 (10.6%)	11 (6.7%)	5 (5.6%)	47 (13.4%)
Cannot determine	42 (2.7%)	16 (1.9%)	6 (3.7%)	4 (4.4%)	8 (2.3%)
Witness status					
EMS, n (%)	167 (10.9%)	113 (13.1%)	24 (14.7%)	9 (10.0%)	45 (12.8%)
Bystander, n (%)	539 (35.1%)	297 (34.5%)	55 (33.7%)	36 (40.0%)	112 (31.8%)
None, n (%)	698 (45.4%)	378 (44.0%)	71 (43.6%)	39 (43.3%)	171 (48.6%)
Unknown, n (%)	133 (8.7%)	72 (8.4%)	13 (8.0%)	6 (6.7%)	24 (6.8%)
Bystander care, n (%)					
No bystander CPR	518 (33.7%)	432 (50.2%)	53 (32.5%)	32 (35.6%)	98 (27.8%)
Bystander CPR, No AED	639 (41.6%)	250 (29.1%)	64 (39.3%)	36 (40.0%)	122 (34.7%)
Bystander CPR and AED	150 (9.8%)	56 (6.5%)	16 (9.8%)	6 (6.7%)	64 (18.2%)
Unknown	230 (15.0%)	122 (14.2%)	30 (18.4%)	16 (17.8%)	68 (19.3%)
Public location, n (%)	208 (13.5%)	73 (8.5%)	18 (11.0%)	9 (10.0%)	44 (12.5%)
Site, n (%)					
A	601 (39.1%)	299 (34.8%)	103 (63.2%)	41 (45.6%)	73 (20.7%)
B	44 (2.9%)	4 (0.5%)	2 (1.2%)	1 (1.1%)	99 (28.1%)
C	102 (6.6%)	261 (30.3%)	0 (0.0%)	2 (2.2%)	0 (0.0%)
D	334 (21.7%)	8 (0.9%)	15 (9.2%)	27 (30.0%)	111 (31.5%)
E	456 (29.7%)	288 (33.5%)	43 (26.4%)	19 (21.1%)	69 (19.6%)

EMS = emergency medicine services; IQR = interquartile range; VT = ventricular tachycardia; VF = ventricular fibrillation; PEA = pulseless electrical activity; CPR = cardiopulmonary resuscitation; AED = automated external defibrillator.

[a] Age was unknown for 3 patients (1 white, 1 black, 1 Hispanic patient).

[b] Sex was unknown for 2 patients (1 white, 1 unknown patient).

[c] This represents the scenario where there was no rhythm strip available to determine the rhythm (asystole or PEA) but no shock was advised per EMS.

multivariable analysis was repeated with survival to hospital discharge as the dependent variable. The controlling variables were selected a priori as they were believed to be associated with the outcome but not on any potential causal pathway between race and the outcome of interest.

Results

Of the 3004 adult OHCA patients included in PART, 3002 had available EMS-assessed race data entered (including unknown) and formed the primary sample for analysis. There were 1537 white, 860 black, and 163 Hispanic patients with an additional 90 patients with race classified as other, which included American-Indian, Alaska Native, Asian, Native Hawaiian, and Pacific Islander, and 352 patients with unknown race. Characteristics of this primary sample are summarized in Table 1. Notable differences include lower rates of a shockable initial rhythm and bystander CPR among black patients compared to patients with race classified as white, Hispanic, other, or unknown. In addition, there were notable differences by racial composition among the five study sites.

The EMS-assessed race demonstrated good agreement (Kappa score = 0.88 (95% CI 0.86, 0.90) with the hospital determination of race in the subset of patients who were transported to a receiving facility and excluding those with unknown race (Table 2). Misclassification of race by EMS providers compared to hospital race occurred in 6.6% of cases, and for 5.2% and 3.2% of white and black patients, respectively. We did not have medical examiner or funeral home data on the confirmed race of patients who died in the field and were not transported to a hospital to make comparisons to EMS-assessed race for all treated individuals.

Table 2 – Comparison between EMS-assessed race and hospital race among transported patients with recorded race/ethnicity.

Hospital race	EMS-assessed race			
	White	Black	Hispanic	Other
White	679	8	5	19
Black	10	447	0	2
Hispanic	5	5	26	1
Other	22	2	5	35

Kappa score = 0.88 (95% CI 0.86, 0.90).

Resuscitation characteristics by EMS-assessed patient race are listed in Table 3. Compared to white patients, black and Hispanic patients had similar rates of initial airway attempt success, time from arrival to CPR, and time from arrival to initial airway attempt. There were minimal differences in time from start of airway attempt to success or abandonment. The proportion of patients transported was also similar between patients regardless of race.

Table 3 – Prehospital intervention characteristics by EMS-assessed race.

n	White 1537	Black 860	Other 90	Hispanic 163	Unknown 352
Time from dispatch to arrival					
Median (IQR)	5.0 (2.3)	5.4 (2.8)	5.4 (2.3)	4.9 (2.0)	5.5 (3.8)
Unknown, n (%)	48 (3.1%)	97 (11.3%)	1 (1.1%)	1 (0.6%)	8 (2.3%)
Time from arrival to CPR					
Median (IQR)	2.0 (2.0)	2.0 (1.9)	1.5 (1.5)	1.5 (1.5)	2.0 (2.1)
Unknown, n (%)	149 (10.9%)	142 (19.0%)	7 (8.6%)	8 (5.8%)	35 (11.4%)
Initial advanced airway attempted, n (%)					
LT	727 (47.3%)	374 (43.5%)	44 (48.9%)	81 (49.7%)	197 (56.0%)
ETI	619 (40.3%)	384 (44.7%)	38 (42.2%)	74 (45.4%)	112 (31.8%)
BVM-only	191 (12.4%)	102 (11.9%)	8 (8.9%)	8 (4.9%)	43 (12.2%)
Time from arrival to airway attempt					
LT – median (IQR)	9.9 (6.2)	10.8 (6.3)	8.2 (5.6)	9.9 (6.5)	9.0 (6.9)
ETI – median (IQR)	11.9 (7.6)	14.1 (7.2)	12.1 (5.9)	13.0 (10.9)	10.8 (8.0)
Initial advanced airway successful					
LT, n (%)	662 (91.1%)	343 (91.7%)	39 (88.6%)	71 (87.7%)	170 (86.3%)
ETI, n (%)	317 (51.2%)	212 (55.2%)	14 (36.8%)	31 (41.9%)	59 (52.7%)
Time from initial airway attempt to success or abandonment					
LT – median (IQR)	0.4 (1.0)	0.5 (1.0)	0.6 (1.0)	0.7 (1.0)	1.0 (1.0)
ETI – median (IQR)	1.0 (1.2)	0.9 (1.1)	0.3 (2.0)	1.0 (1.6)	1.0 (1.0)
Number of airway attempts					
1, n (%)	922 (60.0%)	544 (63.3%)	53 (58.9%)	99 (60.7%)	210 (59.7%)
2, n (%)	273 (17.8%)	130 (15.1%)	18 (20.0%)	32 (19.6%)	63 (17.9%)
3 or more, n (%)	151 (9.8%)	84 (9.8%)	11 (12.2%)	24 (14.7%)	36 (10.2%)

EMS = emergency medical services; IQR = interquartile range; CPR = cardiopulmonary resuscitation; LT = King laryngeal tube; ETI = endotracheal intubation; BVM-only = bag-valve-mask ventilation only.

There were 352 patients in whom an advanced airway was not placed (191 white, 102 black, 8 Hispanic, 8 other, and 43 unknown). A similar proportion of patients across races did not have an advanced airway placed. In citing reasons for why an airway was not attempted, EMS providers cited death before airway attempt in 14.1% of white patients, but noted the same reason in only 7.8% of black patients. However, regaining consciousness was also cited higher in white patients (38.2%) compared to black patients (16.7%).

Patient outcomes by EMS-assessed race are reported in Table 4. There were no differences in rates of ROSC or 72-h survival between

Table 4 – Patient outcomes by EMS-assessed race.

	White	Black	Other	Hispanic	Unknown
Transported from scene, % (n/N)	60.2% (925/1537)	59.3% (510/860)	63.3% (57/90)	65.0% (106/163)	55.7% (196/352)
LT first attempted	57.6% (419/727)	56.4% (211/374)	61.4% (27/44)	60.5% (49/81)	58.9% (116/197)
ETI first attempted	61.6% (381/619)	62.2% (239/384)	65.8% (25/38)	67.6% (50/74)	53.6% (60/112)
BVM-only	65.4% (125/191)	58.8% (60/102)	62.5% (5/8)	87.5% (7/8)	46.5% (20/43)
ROSC at ED arrival, % (n/N)	44.8% (414/925)	40.2% (205/510)	43.9% (25/57)	37.7% (40/106)	51.5% (101/196)
LT first attempted	43.4% (182/419)	43.1% (91/211)	51.9% (14/27)	42.9% (21/49)	49.1% (57/116)
ETI first attempted	39.6% (151/381)	38.1% (91/239)	44.0% (11/25)	34.0% (17/50)	51.7% (31/60)
BVM-only	64.8% (81/125)	38.3% (23/60)	0.0% (0/5)	28.6% (2/7)	65.0% (13/20)
72-h survival, % (n/N)	16.9% (260/1534)	16.3% (140/859)	22.2% (20/90)	14.7% (24/163)	17.3% (61/352)
LT first attempted	14.3% (104/727)	17.6% (66/374)	18.2% (8/44)	16.0% (13/81)	18.3% (36/197)
ETI first attempted	12.5% (77/617)	13.6% (52/383)	31.6% (12/38)	12.2% (9/74)	13.4% (15/112)
BVM-only	41.6% (79/190)	21.6% (22/102)	0.0% (0/8)	25.0% (2/8)	23.3% (10/43)
Survival to hospital discharge, % (n/N)	10.8% (165/1533)	7.6% (65/859)	8.9% (8/90)	8.0% (13/163)	9.4% (33/352)
LT first attempted	7.3% (53/726)	7.8% (29/374)	4.5% (2/44)	8.6% (7/81)	9.1% (18/197)
ETI first attempted	6.5% (40/617)	5.2% (20/383)	15.8% (6/38)	5.4% (4/74)	4.5% (5/112)
BVM-only	37.9% (72/190)	15.7% (16/102)	0.0% (0/8)	25.0% (2/8)	23.3% (10/43)
MRS < = 3, % (n/N)	7.7% (118/1533)	4.0% (34/857)	5.6% (5/89)	4.9% (8/163)	4.8% (17/351)
LT first attempted	4.3% (31/726)	4.3% (16/372)	2.3% (1/43)	3.7% (3/81)	4.6% (9/196)
ETI first attempted	4.1% (25/617)	1.6% (6/383)	10.5% (4/38)	4.1% (3/74)	2.7% (3/112)
BVM-only	32.6% (62/190)	11.8% (12/102)	0.0% (0/8)	25.0% (2/8)	11.6% (5/43)

EMS = emergency medical services; LT = laryngeal tube; ETI = endotracheal intubation; BVM-only = bag-valve-mask ventilation only; MRS = Modified Rankin Scale; ROSC = return of spontaneous circulation.

patients by race. Compared to white patients, black patients had lower unadjusted rates of survival to hospital discharge ($p < 0.05$) and functionally intact discharge ($p < 0.001$). Though Hispanic, other, and unknown race patients had lower survival to discharge and functionally intact survival compared to white patients, these differences were not statistically significant ($p > 0.05$).

Despite similar rates of not having an advanced airway placed, there were additional unadjusted survival differences by race when stratified by airway type. Black patients compared to white patients receiving BVM-only ventilation without advanced airway placement had lower ROSC proportions at ED arrival (38.3% vs. 64.8%), 72-h survival (21.6% vs. 41.6%), survival to hospital discharge (15.7% vs. 37.9%), and functionally intact survival (11.8% vs. 32.6%), respectively, despite similar rates of transport from scene (all p-values <0.001). This was the primary factor in the overall unadjusted survival to hospital discharge being significantly worse for black compared to white patients, as unadjusted survival to hospital discharge were similar between black and white patients when stratified by ETI (5.2% vs. 6.5%) and LT (7.8% vs. 7.3%), respectively (both p-values >0.4).

The association between race and probability of successful prehospital airway placement were also assessed by multivariable regression (Table 5). After controlling for age, sex, the type of initial airway attempted, and the initial EMS service level (basic life support [BLS] vs. advanced life support [ALS]), there were no differences in odds of successful airway placement for black patients compared to white patients (OR [95% CI]: 1.13 [0.90, 1.41]), Hispanic (0.73 [0.49, 1.08]), other (0.64 [0.38, 1.05]), or unknown (0.83 [0.60, 1.16]). Among all patients, the LT had higher odds of placement success compared to ETI (9.35 [7.48, 11.68]).

For multivariable patient outcome comparisons, only white and black patients were used due to significantly lower numbers of enrolled patients of other races (Table 6). Compared to white patients, black patients had no differences in 72-h survival (OR [95% CI]: 1.06 [0.81, 1.39]) or survival to discharge (0.82 [0.57, 1.19]) when adjusting for key covariates including age, sex, witness status, initial rhythm, bystander CPR, time from dispatch to arrival, randomization cluster, and whether or not an advanced airway was attempted.

Table 5 – GEE model estimates for advanced airway success.

	Model OR (95% CI)
EMS-assessed race	
White	Reference
Black	1.13 (0.90, 1.41)
Other	0.64 (0.38, 1.05)
Hispanic	0.73 (0.49, 1.08)
Unknown	0.83 (0.60, 1.16)
Age	1.00 (1.00, 1.01)
Sex	
Female	Reference
Male	0.84 (0.68, 1.02)
First airway attempted	
Endotracheal intubation	Reference
Laryngeal tube	9.35 (7.48, 11.68)
First arriving service level	
BLS	Reference
BLS-D	0.58 (0.33, 1.00)
BLS+	0.47 (0.28, 0.79)
ALS	0.69 (0.42, 1.14)

GEE = generalized estimating equation; OR = Odds Ratio for advanced airway success; BLS = basic life support; ALS = advanced life support.

Table 6 – GEE model estimates for patient outcomes by EMS-assessed race (white or black).

	72-h survival OR (95% CI)	Survival to discharge OR (95% CI)
EMS-assessed race		
White	Reference	Reference
Black	1.06 (0.81, 1.39)	0.82 (0.57, 1.19)
Age	0.98 (0.97, 0.98)	0.97 (0.96, 0.98)
Sex		
Female	Reference	Reference
Male	1.08 (0.84, 1.38)	1.12 (0.80, 1.58)
Witness status		
EMS	Reference	Reference
Bystander	0.45 (0.17, 1.22)	0.91 (0.24, 3.38)
None	0.19 (0.07, 0.50)	0.31 (0.08, 1.18)
Unknown	0.35 (0.12, 0.97)	0.74 (0.20, 2.81)
Initial EMS rhythm		
VT, VF	Reference	Reference
PEA	0.37 (0.26, 0.53)	0.24 (0.16, 0.38)
Asystole	0.17 (0.12, 0.24)	0.07 (0.04, 0.12)
No shock advised[a]	0.19 (0.11, 0.36)	0.20 (0.09, 0.43)
Cannot determine	0.72 (0.39, 1.34)	0.78 (0.39, 1.60)
Bystander CPR status		
No bystander CPR	Reference	Reference
Bystander CPR, no AED	0.94 (0.72, 1.25)	1.19 (0.82, 1.74)
Bystander CPR and AED	0.53 (0.21, 1.35)	1.07 (0.31, 3.69)
Time from dispatch to 1st arrival	0.95 (0.89, 1.01)	0.95 (0.95, 1.04)
BVM-only (no AA attempt)	2.62 (1.95, 3.52)	4.99 (3.50, 7.11)

GEE = generalized estimating equation; EMS = emergency medical services; OR = Odds ratio; VT = pulseless ventricular tachycardia; VF = ventricular fibrillation; PEA = pulseless electrical activity, CPR = cardiopulmonary resuscitation, AED = automated external defibrillator, BVM-only = bag-valve-mask ventilation only, AA = advanced airway.
[a] This represents the scenario where there was no rhythm strip available to determine the rhythm (asystole or PEA) but no shock was advised per EMS.

Discussion

In this multi-region study, we demonstrate no significant differences in airway success or patient outcomes by EMS-assessed patient race after adjusting for possible confounders in the multivariable analysis. In agreement with prior studies,[2,4,5,14–16] we found lower unadjusted survival to discharge among black patients compared to white patients. Black patients also had a lower proportion of initial shockable rhythms and bystander CPR compared to white patients. These differences may be due to socioeconomic factors and could, in part, explain the lower unadjusted survival to discharge. There was the additional finding of an unadjusted lower survival among black patients compared to white patients when they were treated with only with BVM-only ventilation and not an advanced airway, though this finding may be explained by the presence of significant unmeasured confounders.

There was good agreement in our study between the EMS-assessed race and the hospital race for white and black patients. The

majority of prior studies that have examined the impact of patient race on interventions and outcomes in OHCA have not specified whether the race used was obtained from hospital records, vital records, self-reported, or as assessed by the treating provider. The prior studies that do report a specific source for race cite hospital or vital records.[2,9,15] One would theorize that the perceived race, as assessed by the treating EMS provider, might have the greatest impact on bias. Thus, we report one of the first evaluations of differences in OHCA interventions and outcomes by EMS-assessed race.

Prior studies evaluating racial disparities in OHCA have reported lower rates of shockable rhythms,[2,4,8,9] witnessed arrests,[2,8] bystander CPR,[2,4,9] and survival[2,4,5,14–16] among black compared to white patients. In some of these prior studies, survival differences persisted even after multivariable analyses controlling for potential confounders,[2,4] while in others these survival differences lost statistical significance after adjustment for confounders,[5,15] as was the case in our study. There have additionally been several studies that found no unadjusted or adjusted difference in survival to hospital discharge between white and black patients.[8,9,15] In a meta-analysis of 15 studies evaluating black compared to white OHCA patients, black patients were found to have significantly lower odds of receiving bystander CPR, having a witnessed arrest, having a shockable rhythm, and surviving to hospital admission or discharge.[7]

For Hispanic patients, prior studies have shown lower odds of bystander CPR, an initial shockable rhythm, and survival to discharge.[6,10] However, our sample is underpowered to detect significant differences in intervention variables or outcomes in Hispanic as compared to white patients. We did not find any significant differences in bystander CPR, shockable rhythms, or survival outcomes comparing Hispanic to white patients in an unadjusted analysis.

There have been studies of prehospital management of patients by EMS personnel showing that black patients receive analgesics for pain control less often compared to white patients for the same diagnoses,[17,18] mirroring studies in the emergency department setting that have shown similar disparities between white, black, and Hispanic patients.[19] Few prior studies have specifically evaluated differences in EMS interventions, not just time from dispatch to arrival, by patient race for OHCA patients. A 1994 study[8] reported no differences in the rate of defibrillation or intubation by EMS providers between white and black patients. A more recent study found fewer defibrillations provided by EMS for black compared to white patients.[20] However, this study did not report on the rate of shockable rhythms between white or black patients and this difference could possibility be explained by a lower rate of shockable rhythms among black compared to white patients. We found similar times from arrival to starting CPR, defibrillation, starting an advanced airway attempt, and obtaining a successful advanced airway across races. We did find worse survival among black patients receiving BVM-only ventilation, but this may be due to lower proportions of shockable rhythms and bystander CPR in black compared to white patients in our cohort, and thus a higher proportion of white patients receiving BVM-only ventilation may have had a quick return of perfusion compared to black patients.

Limitations

Our study was limited by not knowing the racial makeup of the EMS providers that were providing care to each OHCA patient. Knowledge of this information would have afforded an additional layer of analysis. We were also limited by the significant variation in racial demographics across agencies, though we did attempt to control for this by including randomization cluster in our multivariable analysis. The degree of unknown times from dispatch to arrival also varied by site, with a higher proportion of unknown times from sites with higher percentages of black patients. However, within each site the percentage of unknown times from dispatch to arrival were similar between patients regardless of race. Therefore, by adjusting for study clusters in our multivariable model, in addition to time from dispatch to arrival, we hope to have accounted for any such variation.

The study was also limited by low numbers of Hispanic patients and patients of other races aside from white and black. Patients of non-white and non-black race were also more frequently misclassified by EMS personnel, further limiting conclusions that can be made from our study as to the disparities between Hispanic and other minority groups in OHCA care and outcomes. As noted, we were only able to correlate EMS-assessed race with hospital race in the convenience sample patients who were transported from the scene and so may have under- or over-estimated the true prevalence of misclassification. Additionally, it could be that differences in interventions by prehospital providers by patient race are less prominent in scenarios with protocol driven care such as cardiac arrest and future studies to evaluate if this is the case are necessary. Our studies generalizability is also limited as the care evaluated in this study was conducted during a randomized controlled trial as part of the PART study. We also do not have data on whether there were differences in dispatcher-initiated CPR rates by patient race or data related to the quality of CPR metrics by patient race. Finally, our study lacks specific data regarding the type of hospital the patients were admitted to and specifics of their care during their inpatient course and how this may or may not have varied by patient race.

Conclusion

In one of the largest studies evaluating differences in prehospital interventions by EMS-assessed race for OHCA patients, we found no significant differences to suggest disparities related to EMS care. Though black patients did have lower proportions of shockable initial rhythms, bystander CPR, and survival to discharge, there were no survival outcome differences by race on adjusted analysis.

Funding

This study was supported by award UH2/UH3-HL125163 from the NHLBI. The Resuscitation Outcomes Consortium institutions participating in the trial were supported by a series of cooperative agreements from the NHLBI, including 5U01 HL077863 (University of Washington Data Coordinating Center), HL077866 (Medical College of Wisconsin), HL077871 (University of Pittsburgh), HL077873 (Oregon Health and Science University), HL077881 (University of Alabama at Birmingham), and HL077887 (University of Texas Southwestern Medical Center/Dallas). Ambu.® Inc. provided laryngeal tube airways to replace equipment used by emergency medical services (EMS) agencies during the trial. The content is solely the responsibility of the authors and does not necessarily represent the official views of the NHLBI or the NIH.

Conflict of interest statement

Dr. Wang received grants from the National Institutes of Health (NIH)/ National Heart, Lung, and Blood Institute (NHLBI) and provided research consultation for Shire Inc. Mr. Schmicker; Drs. Daya and Aufderheide reported receiving grants from the NHLBI. Dr. Nichol reported receiving salary support from Medic One Foundation; grants from NIH, Agency for Healthcare Research and Quality, and US Food and Drug Administration; and contracts from Abiomed, GE Healthcare, and ZOLL Medical Corp, and providing consultancy to ZOLL Circulation. All other authors report no conflicts of interest.

CRediT authorship contribution statement

Joshua R. Lupton: Conceptualization, Methodology, Project administration, Writing - original draft, Writing - review & editing. **Robert H. Schmicker:** Conceptualization, Data curation, Formal analysis. **Tom P. Aufderheide:** Methodology, Writing - review & editing. **Audrey Blewer:** Methodology, Writing - review & editing. **Clifton Callaway:** Methodology, Writing - review & editing. **Jestin N. Carlson:** Methodology, Writing - review & editing. **M. Riccardo Colella:** Methodology, Writing - review & editing. **Matt Hansen:** Methodology, Writing - review & editing. **Heather Herren:** . **Graham Nichol:** Methodology, Writing - review & editing. **Henry Wang:** Conceptualization, Methodology, Supervision, Writing - review & editing. **Mohamud R. Daya:** Conceptualization, Methodology, Supervision, Writing - review & editing.

Acknowledgements

We want to acknowledge and thank all the participating EMS agencies that supported and helped provide data for this project.

REFERENCES

1. Chan PS, McNally B, Tang F, Kellermann A. Recent trends in survival from out-of-hospital cardiac arrest in the United States. Circulation 2014;130:1876–82.
2. Becker LB, Han BH, Meyer PM, et al. Racial differences in the incidence of cardiac arrest and subsequent survival. The CPR Chicago Project. N Engl J Med 1993;329:600–6.
3. Bosson N, Fang A, Kaji AH, et al. Racial and ethnic differences in outcomes after out-of-hospital cardiac arrest: Hispanics and Blacks may fare worse than non-Hispanic Whites. Resuscitation 2019;137: 29–34.
4. Cowie MR, Fahrenbruch CE, Cobb LA, Hallstrom AP. Out-of-hospital cardiac arrest: racial differences in outcome in Seattle. Am J Public Health 1993;83:955–9.
5. Galea S, Blaney S, Nandi A, et al. Explaining racial disparities in incidence of and survival from out-of-hospital cardiac arrest. Am J Epidemiol 2007;166:534–43.
6. Moon S, Bobrow BJ, Vadeboncoeur TF, et al. Disparities in bystander CPR provision and survival from out-of-hospital cardiac arrest according to neighborhood ethnicity. Am J Emerg Med 2014;32:1041–5.
7. Shah KS, Shah AS, Bhopal R. Systematic review and meta-analysis of out-of-hospital cardiac arrest and race or ethnicity: black US populations fare worse. Eur J Prev Cardiol 2014;21:619–38.
8. Brookoff D, Kellermann AL, Hackman BB, Somes G, Dobyns P. Do blacks get bystander cardiopulmonary resuscitation as often as whites? Ann Emerg Med 1994;24:1147–50.
9. Chu K, Swor R, Jackson R, et al. Race and survival after out-of-hospital cardiac arrest in a suburban community. Ann Emerg Med 1998;31:478–82.
10. Vadeboncoeur TF, Richman PB, Darkoh M, Chikani V, Clark L, Bobrow BJ. Bystander cardiopulmonary resuscitation for out-of-hospital cardiac arrest in the Hispanic vs the non-Hispanic populations. Am J Emerg Med 2008;26:655–60.
11. Hall WJ, Chapman MV, Lee KM, et al. Implicit racial/ethnic bias among health care professionals and its influence on health care outcomes: a systematic review. Am J Public Health 2015;105:e60–76.
12. Dehon E, Weiss N, Jones J, Faulconer W, Hinton E, Sterling S. A systematic review of the impact of physician implicit racial bias on clinical decision making. Acad Emerg Med 2017;24:895–904.
13. Wang HE, Schmicker RH, Daya MR, et al. Effect of a strategy of initial laryngeal tube insertion vs endotracheal intubation on 72-hour survival in adults with out-of-hospital cardiac arrest: a randomized clinical trial. JAMA 2018;320:769–78.
14. McNally B, Robb R, Mehta M, et al. Out-of-hospital cardiac arrest surveillance—Cardiac Arrest Registry to Enhance Survival (CARES), United States, October 1, 2005–December 31, 2010. MMWR Surveill Summ (Washington, DC: 2002) 2011;60:1–19.
15. Sayegh AJ, Swor R, Chu KH, et al. Does race or socioeconomic status predict adverse outcome after out of hospital cardiac arrest: a multicenter study. Resuscitation 1999;40:141–6.
16. Merchant RM, Becker LB, Yang F, Groeneveld PW. Hospital racial composition: a neglected factor in cardiac arrest survival disparities. Am Heart J 2011;161:705–11.
17. Hewes HA, Dai M, Mann NC, Baca T, Taillac P. Prehospital pain management: disparity by age and race. Prehosp Emerg Care 2018;22:189–97.
18. Kennel J, Withers E, Parsons N, Woo H. Racial/ethnic disparities in pain treatment: evidence from Oregon emergency medical services agencies. Med Care 2019;57:924–9.
19. Lee P, Le Saux M, Siegel R, et al. Racial and ethnic disparities in the management of acute pain in US emergency departments: meta-analysis and systematic review. Am J Emerg Med 2019;37:1770–7.
20. Wilde ET, Robbins LS, Pressley JC. Racial differences in out-of-hospital cardiac arrest survival and treatment. Emerg Med J 2012;29:415–9.