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Racial disparities in outcomes following PEA and asystole in-hospital cardiac arrests

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Abstract

Aim—To define the racial differences present after PEA and asystolic IHCA and explore factors that could contribute to this disparity

Methods—We analyzed PEA and asystolic IHCA in the Get-With-The-Guidelines-Resuscitation database. Multilevel conditional fixed effects logistic regression models were used to estimate the relationship between race and survival to discharge and return of spontaneous circulation (ROSC), sequentially controlling for hospital, patient demographics, comorbidities, arrest characteristic, process measures, and interventions in place at time of arrest.

Results—Among the 561 hospitals, there were 76,835 patients who experienced IHCA with an initial rhythm of PEA or asystole (74.8% white, 25.2% black). Unadjusted ROSC rate was 55.1% for white patients and 54.1% for black patients (unadjusted OR: 0.94 [95% CI, 0.90–0.98], p=0.016). Survival to discharge was 12.8% for white patients and 10.4% for black patients (unadjusted OR: 0.83 [95% CI, 0.78–0.87], p<0.001). After adjusting for temporal trends, patient characteristics, hospital, and arrest characteristics, there remained a difference in survival to discharge (OR: 0.85 [95% CI, 0.79–0.92]) and rate of ROSC (OR: 0.88 [95% CI, 0.84–0.92]).

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Black patients had a worse mental status at discharge after survival. Rates of DNAR placed after survival from were lower in black patients with a rate of 38.3% compared to 44.5% in white patients ($p<0.001$).

Conclusion—Black patients are less likely to experience ROSC and survival to discharge after PEA or asystole IHCA. Individual patient characteristics, event characteristics, and hospital characteristics don't fully explain this disparity. It is possible that disease burden and end-of-life preferences contribute to the racial disparity.

Keywords

Heart arrest; Cardiopulmonary resuscitation; Defibrillation; Chest compression; Racial Disparity

Introduction

In the US, African-Americans experience significant health disparities across a range of medical conditions, including cardiac arrest outcomes, both in and out of the hospital.[1–5] Out-of-hospital arrest disparities have been explained in part by factors such as increased time to emergency medical services arrival, decreased rate of bystander cardiopulmonary resuscitation (CPR), decreased likelihood of having the arrest be witnessed, and decreased rate of ventricular tachycardia (VT) or ventricular fibrillation (VF).[1, 2, 6, 7] For in-hospital cardiac arrests (IHCA), work elucidating racial differences in outcomes has focused on arrests due to ventricular arrhythmias, where hospital-level factors (i.e. racial clustering in hospitals with worse outcomes) were found to be a large contributor.[5]

The vast majority of IHCA are due to pulseless electrical activity (PEA) or asystole.[8, 9] While VT and VF are often due to cardiac etiologies, PEA and asystolic arrests have a multifactorial etiology and lower overall survival.[8–12] In addition, intra- and post-resuscitation management differs greatly from arrests due to VF and VT, where the focus tends to be on defibrillation and cardiac catheterization.[13] Because of the wider array of reasons which cause PEA and asystolic arrests, there may be additional or alternative factors which cause racial disparities in these rhythms. These factors, which possibly play a role in arrest outcomes, include difference in end-of-life decisions and level of control of chronic medical conditions. We sought to further define the racial differences present after IHCA with initial rhythm of PEA and asystole and explore factors that could be contributing to this disparity. To our knowledge, this is the first study to focus on racial disparities for in-hospital cardiac arrests which are of PEA or asystole.

Methods

We analyzed data from the American Heart Association's Get With The Guidelines®-Resuscitation (GWTG-R) registry (formerly National Registry of Cardiopulmonary Resuscitation). This is an American Heart Association (AHA) sponsored quality improvement registry database of IHCA which has previously been described.[8] Hospitals participate voluntarily and provide information about their facility, staffing, and resuscitation services. Information is collected from patients' hospital charts, cardiac arrest record sheets, paging system logs, pharmacy records of drugs utilized in resuscitation efforts, and billing charge sheets. All the data collected are entered utilizing Utstein definitions.[14] Outcome, A Quintiles Company, is the data collection coordination center for the American Heart Association/American Stroke Association Get With The Guidelines® programs.

The GWTG-R has also been linked to the American Hospital Association's database, which contains information about 6500 hospitals in the US. From this, we abstracted hospital characteristics, including bed size, geographic location of hospital, presence of residency training program, and whether the hospital was in an urban or rural setting.

In our analysis, we included all IHCA between 2000 and 2009. Our analysis included patients whose initial cardiac arrest rhythm was asystole or PEA. Patients were included if they were identified, through their medical records, as black or white. Cardiac arrests that occurred in procedure suites, operation rooms, ambulatory units, or the emergency department were excluded. Patients with missing or unknown initial rhythm of arrest and race were also excluded (Figure 1).

Study Outcomes and Variables

The primary outcome was survival to hospital discharge, and the secondary outcome was return of spontaneous circulation (ROSC) for 20 minutes post-resuscitation. Patient race was the primary independent variable. Patient factors included age, sex, initial rhythm, co-morbidities prior to cardiac arrest, and interventions in place at the time of resuscitation. Resuscitation event characteristics included length of cardiac arrest, day of week, and time of day. End-of-life measures including DNAR status, length of time from achieving ROSC to DNAR, and reason resuscitation ended were also extracted, as were pressors used during the resuscitation.

Statistical Analysis

Patient, event, hospital, and end-of-life care characteristics as well as unadjusted outcomes were compared between white and black patients using chi-squared tests for categorical data and t-tests for continuous data. Adjustment for confounders that may account for differences between white and black patients was performed by sequentially controlling for different types of covariates. First, a generalized estimating equation model was used to estimate the average survival difference between black and white patients in the study population. Then, multilevel conditional fixed-effects logistic regression models were used to estimate the relationship between race and survival to discharge, sequentially controlling for: 1) hospital factors and temporal trends, 2) patient age, sex, rhythm type, and event characteristics, 3) patient co-morbidities, and 4) interventions in place at the time of the event. A fixed effects model is akin to adding a dummy variable for each hospital into the model, which allows these hospital variables to be correlated with both the variable of interest and the outcome. Thus, the hospital characteristics (both measured and unmeasured) are controlled for as potential confounders in the model.[15] A secondary analysis was performed in the same manner for ROSC. In addition, a subgroup analysis for survival to discharge was conducted based on the type of vasopressors used during the resuscitation.

Statistical analyses were performed using Stata, version 12.0 (StataCorp). All significance tests used a 2-sided p-value <0.05.

Results

Pre-Arrest Characteristics

Our final analysis included 76,835 patients from 561 hospitals who experienced IHCA with an initial rhythm of PEA or asystole. Of these, 57,149 were white (74.8%) and 19,236 were black (25.2%). Table 1 shows baseline sociodemographic and clinical information by race. White patients were older and more likely to be male. Cardiac diagnosis (CHF, MI, or arrhythmias) were found more often in white patients. Black patients were more likely to have renal insufficiency, diabetes, sepsis, and baseline CNS depression. Of patients in a non-intensive care setting, black patients were less likely to be in a telemetry bed.

White patients were more likely to have cardiac interventions in place, such as intra-arterial balloon pumps and pulmonary artery catheters, while black patients were more likely to be intubated and receiving vaso-active medications.

e Table 1 shows the differences in hospital characteristics. Hospitals in this study had proportions of black patients that reflect the geographic distribution of blacks within the United States.[16] Hospitals that were larger and had approved training programs had a higher percentage of black IHCA patients.

Event Characteristics

Measured variables from the arrest were also analyzed for the two groups (Table 2). White patients were more likely than black patients to have an initial rhythm of asystole (47.8% vs 44.7%; p<0.001). We can also see that non-ICU black patients were more likely to be on the general floor, as opposed to under telemetry monitoring (23.4% vs 21.2%; p<0.001). There was little to no difference in the proportion of weekend arrest (36.2% vs 36%; p=0.72), but there was a difference between night arrests (36.5% for white patients vs 34.4% for black patients; p<0.001) and witnessed arrests (78.8% for white patients vs 77.1% for black patients; p<0.001). Hospital wide resuscitation teams were found at 86.9% of hospitals where white patients experienced IHCA, which was significantly higher than 82.9% of hospitals were black patients experienced IHCA (p<0.001).

Arrest Outcomes

The unadjusted ROSC rate after IHCA was 55.1% for white patients and 54.1% for black patients (Table 3). This difference appeared to be mediated by the asystole arrests, in subgroup analysis, rather than PEA, where there was not a significant difference in ROSC rates. The difference appeared more pronounced after adjusting for temporal trends, hospital, patient characteristics, and arrest characteristics (unadjusted OR: 0.94 [95% CI, 0.90–0.98] vs adjusted OR: 0.88 [95% CI, 0.84–0.92]) (Table 4).

The rate of survival to hospital discharge for black patients was 10.4% versus 12.8% for white patients, with a more pronounced difference noted in asystole (Table 3). Similarly, the disparity was not resolved with adjusting for potential confounders (unadjusted OR: 0.84

[95% CI, 0.79–0.89] vs adjusted OR: 0.85 [95% CI, 0.79–0.92]) (Table 4). Disparities were also noted in discharge location and neurological status on discharge, with white patients being more likely to have a CPC 1 ($p<0.001$) and be discharged home ($p=0.02$) (Table 3). The difference in neurological status was apparent even after adjusting for potential confounders (adjusted OR: 0.67 [95% CI 0.57–0.80]).

Do Not Attempt Resuscitation (DNAR) Status

As a possible marker of end-of-life decision making characteristics, we calculated the rates of DNAR orders for patients after survival from IHCA. Unadjusted data shows that black patients had a lower incidence of DNAR orders in place post-arrest (38.3% for black patients vs 44.5% for white patients; $p<0.001$) (Table 5). These were put in place later compared to those put in place by white patients, with a median difference of almost 5 hours ($p<0.001$). In addition, for those that did have DNAR orders in place, white patients were more likely to have care withdrawn after an IHCA when compared to black patients (31.4% for white patients vs 24.8% for black patients; $p<0.001$).

Discussion

We conducted the largest study to date of racial disparities in in-hospital cardiac arrest and found that black patients in PEA and asystole have worse outcomes than their white counterparts. Not only did we find that black patients were significantly more likely to die in the hospital after cardiac arrest, those that survived were more 33% less likely to be discharged with normal mental status. These outcomes support prior results in VF/VT. However, in contrast to that work, the disparities in this analysis persisted after adjusting for known patient and hospital level characteristics, as well as clustering by hospital, suggesting that unmeasured characteristics contribute to the disparities in PEA and asystole to a greater extent than for ventricular arrhythmias. We found no evidence to suggest that black patients were receiving less aggressive resuscitation. In fact, resuscitations in black patients were statistically longer and resulted in increased use of epinephrine. In addition, we found that post-arrest, black patients were less likely to receive a do-not-attempt-resuscitation (DNAR) order and if they did, it was likely to occur later in the process. Also, they were less likely to have care withdrawn once declared DNAR.

If such a pattern were present in the patients preceding cardiac arrest, it could have skewed the sample in favor of white patients for whom resuscitation was attempted, being more “resuscitatable,” because those unlikely to survive were dropped from the sample by virtue of a DNAR order before they arrest. Unfortunately this data set only includes patients who suffer a cardiac arrest and so disparities in pre-arrest DNAR are not knowable. However, with the exception of cardiac interventions, black patients in this cohort were more likely to have intensive interventions in place at the time of arrest, including mechanical ventilation and pressor support, suggesting a more aggressive approach.

While, in general, DNAR orders are often underutilized in patients at high risk of impending death, this is more likely to be the case in black patients, who are more likely to receive life-prolonging measures (such as feeding tubes, mechanical ventilation, ICU admission and CPR) and less likely to receive comfort-directed care or be enrolled in hospice.[17–25]

National data also shows that black patients are more likely to die in the hospital when compared to white patients.[26, 27] In addition, reversal of DNAR is also seen more often in black patients as is revoking hospice.[22, 28] Furthermore, while discussions about end-of-life care seem to assist white patients in receiving less life-prolonging care, they do not have a similar effect on black patients.[29] Racial differences in DNAR use have been tied to black patients having less access to information about advanced directives, discordance between patient and physician race, and cultural differences.[30, 31] Large, academic hospitals, of which black patients in this study were likely to be in, also tend to have lower DNAR rates, but clustering by hospital did not alleviate the disparity in outcomes.[32] Another complicating factor may be the age at which patients have their cardiac arrest. In this study, black patients were on average 8 years younger than their white counterparts, which may increase the barrier to addressing end-of-life care.

Aside from end-of-life care, other factors which may play a role in the racial disparity in outcomes are prevalence of chronic medical conditions and control of these conditions, which have been shown to be worse in black patients. Literature shows that not only is incidence of diabetes higher among black individuals, glycemic control tends to be worse also.[33–35] And while white individuals tend to have greater prevalence of chronic kidney disease, black individuals have a much higher prevalence of end stage renal disease.[36, 37] For neoplastic diseases, black individuals are likely to be diagnosed at higher stages for certain cancers and for others, they're likely to have higher mortality and co-morbidity burden at the same stage.[38, 39] While our analysis controls for presence of chronic condition, the data only provided the variables as dichotomous and so we were unable to control for the severity of the condition, a potential unmeasured confounder. Finally, one other variable that raises the question about potential unmeasured confounders is the disparity in pre-arrest bed allocation with a greater number of black patients arresting in non-telemetry settings. Further work to elucidate the etiology behind this may shed additional light on the disparities in outcomes seen in this study.

Our study contributes to the current body of literature on IHCA by showing that there is racial disparity present in PEA and asystole IHCA. Coupled with other work related to end-of-life care and racial disparities, we postulate that disease burden and end-of-life preferences may contribute to this disparity. The study has several important limitations. First, as this is an observational study, we are only able to show associations. In addition, as the data include only those patients who had a cardiac arrest, we are unable to compare differences in pre-arrest patient cohorts. Finally, although racial disparities in health are closely tied to access to care and economic status, we were unable to control for those variables in our dataset.

Conclusions

We conclude that significant racial disparities exist in outcomes between black and white victims of in-hospital cardiac arrest. However the etiology for these differences remains to be determined. It does not appear to be related to more aggressive resuscitation attempts in white patients but may in fact be a product of inclusion of patients for whom resuscitation was unlikely to be successful and thus may have benefited from more attention to pre-arrest goals of care. While VF/VT arrest outcomes may be improved by focusing on hospital characteristics, these are less likely to have an impact on PEA and asystole IHCA.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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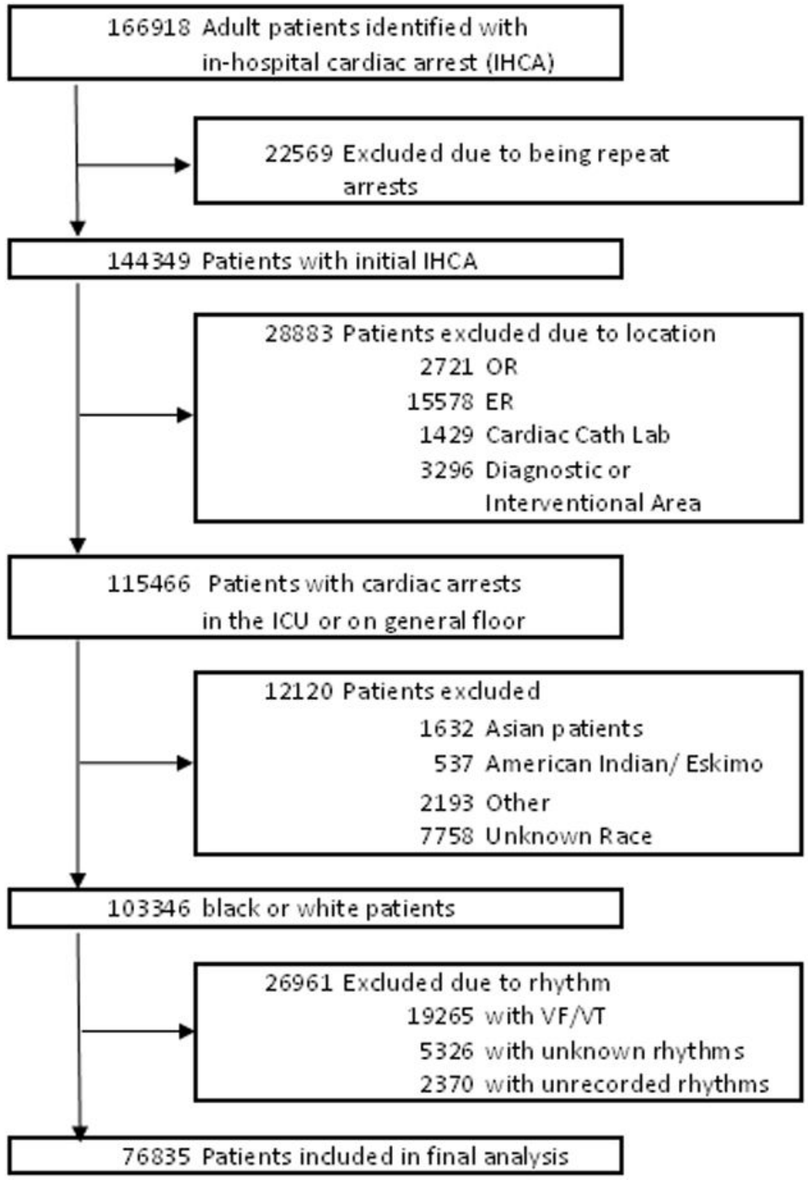

Figure 1. Study population

Abbreviations: IHCA, in-hospital cardiac arrest; OR, operating room; ER, emergency room; Cath, catheterization; ICU, intensive care unit; VF, ventricular fibrillation; VT, ventricular tachycardia

Table 1

Individual patient characteristics

	White [n = 57149]	Black [n = 19236]	p
Age, mean (SD), years	71 (15.2)	63(16.5)	<0.001
Male	33532 (58.8)	10038 (52.2)	<0.001
Pre-Existing Conditions			
Prior MI	9154 (17.5)	1951 (11.5)	<0.001
MI during this admission	8647(16.5)	1662 (9.8)	<0.001
Arrhythmias	17318 (33.1)	4623 (27.3)	<0.001
Prior CHF	11364 (21.7)	3740 (22.1)	0.38
CHF this admission	9940 (19.0)	3010 (17.8)	<0.001
DM	15680 (30.0)	6065 (35.8)	<0.001
Hepatic Insufficiency	4193 (8.0)	1700 (10.0)	<0.001
Electrolyte Abnormality	9620 (18.4)	3683 (21.7)	<0.001
Renal Insufficiency	17647 (33.8)	7819 (46.1)	<0.001
PNA	8403 (16.1)	3076 (18.1)	<0.001
Hypotension/Hypoperfusion	15618 (29.9)	4980 (29.4)	0.21
Trauma	2004 (3.8)	542 (3.2)	<0.001
Sepsis	8961 (17.1)	4023 (23.7)	<0.001
Neoplastic process	7441 (14.2)	2565 (15.1)	0.004
Respiratory Insufficiency	23657 (45.2)	7733 (45.6)	0.42
Baseline CNS depression	6735 (12.9)	2928 (17.3)	<0.001
Acute Stroke	1995 (3.8)	1013 (6.0)	<0.001
Acute non-stroke neurological event	4186 (8.0)	1562 (9.2)	<0.001
Prior to Admission Location			<0.001
SNF	4448 (7.8)	2117 (11.0)	
Home	42145 (73.8)	14002 (72.8)	
Other Hospital	6503 (11.4)	1554 (8.1)	
Interventions in Place prior to Arrest			
Pacemaker	4046 (7.1)	852 (4.4)	<0.001
Intra-aortic balloon pump	704 (1.3)	96 (0.5)	<0.001
Continuous Anti-Arrhythmics	2710 (5.0)	649 (3.6)	<0.001
PA Catheter	2177 (4.0)	465 (2.6)	<0.001
Central Venous Access	8164 (14.3)	3330 (17.3)	<0.001
Invasive airway	16675 (29.2)	6680 (34.7)	<0.001
Assisted or mechanical ventilation	17526 (30.7)	6749 (35.1)	<0.001
Vaso-active medications	15743 (28.9)	5487 (30.2)	0.001
Dialysis or Extracorporeal filtration therapy	1898 (3.5)	1005 (5.5)	<0.001
Intra-arterial catheter	5713 (10.0)	1920 (10.0)	0.95

All results shown as n (%) unless otherwise indicated. Abbreviations: MI- Myocardial Infarction; CHF- Congestive Heart Failure; PNA- Pneumonia; CNS- Central Nervous System; SNF- Skilled Nursing Facility.

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Table 2

Event Characteristics

	White	Black	P
Type of Initial Rhythm			<0.001
Asystole	27312 (47.8)	8602 (44.7)	
PEA	29837 (52.2)	10634 (55.3)	
Location at Time of Arrest			<0.001
ICU	32773 (57.3)	11063 (57.5)	
General Floor	12127 (21.2)	4494 (23.4)	
Telemetry Floor	12248 (21.4)	3678 (19.1)	
Code duration, median (Q25–75), min			
Overall	17 (10–27)	17 (10–27)	0.20
Achieved ROSC (Q25–75)	14 (7–26)	14 (7–25)	0.54
No ROSC (Q25–75)	19 (13–28)	20 (13–28)	0.003
Asystole (Q25–75)	16 (10–26)	17 (10–25)	0.01
PEA (Q25–75)	17 (9–28)	17 (9–27)	0.57
Epinephrine boluses, median (Q25–75), n			
Overall	3 (2–4)	3 (2–4)	<0.001
Achieved ROC	2 (1–3)	2 (1–4)	<0.001
No ROC	3 (2–5)	3 (3–5)	<0.001
Weekend Arrest	18552 (36.2)	6186 (36.0)	0.72
Night Arrest	20717(36.5)	6566(34.4)	<0.001
Witnessed Arrest	45028(78.8)	14829(77.1)	<0.001
Hospital Wide Arrest Response Team	49636(86.9)	15951(82.9)	<0.001

All results shown as n (%) unless otherwise indicated. Abbreviations: PEA- Pulseless Electrical Activity; ICU- Intensive Care Unit; ROSC- Return of Spontaneous Circulation

Table 3

Unadjusted outcomes

	White	Black	p
Return of Spontaneous Circulation for >20 min	31467 (55.1)	10398 (54.1)	0.016
Length of Stay, median (Q25–75), days	5.1 (1.5–13.2)	6.1 (1.9–15.8)	<0.001
Survival for 24 hrs	15591 (27.3)	4923 (25.6)	<0.001
Survival to discharge	7277 (12.8)	1994 (10.4)	<0.001
Discharge Location			0.03
Home	2550 (35.1)	641 (32.2)	
Hospice	465 (6.4)	123 (6.2)	
Other hospital	740 (10.2)	202 (10.1)	
Rehab	1291 (17.8)	327 (16.4)	
SNF	1972 (27.1)	619 (31.0)	
ROSC by Rhythm			
Asystole	13938 (51.0)	4081 (47.5)	<0.001
PEA	17529 (58.8)	6317 (59.4)	0.24
Survival to discharge by Rhythm			
Asystole	3301 (12.1)	735 (8.6)	<0.001
PEA	3976 (13.34)	1259 (11.9)	<0.001
Cerebral Perfusion Category at Discharge			<0.001
1	2858 (40.0)	639 (31.9)	
2	2074 (28.3)	544 (27.2)	
3	1047 (14.3)	380 (19.0)	
4	299 (4.1)	164 (8.2)	

All results shown as n (%) unless otherwise indicated. Abbreviations: ROSC- Return of Spontaneous Circulation; PEA: Pulseless Electrical Activity

Table 4

Association between race and adjusted arrest outcomes

	OR	95% Confidence Interval	
Survival to Discharge			
Unadjusted outcome	0.84	0.79	0.89
Adjusted for temporal trends and hospital	0.86	0.81	0.92
Adjusted for above plus age, sex, rhythm type, event location, and event characteristics[a]	0.82	0.76	0.87
Adjusted for above plus co-morbidities[b]	0.86	0.80	0.92
Adjusted for above plus interventions in place[c]	0.85	0.79	0.92
PEA, fully adjusted for above variables	0.92	0.83	1.00
Asystole, fully adjusted for above variables	0.77	0.68	0.86
Return of Spontaneous Circulation			
Unadjusted outcome	0.94	0.90	0.98
Adjusted for temporal trends and hospital	0.93	0.90	0.97
Adjusted for above plus age, sex, rhythm type, event location, and event characteristics[a]	0.90	0.86	0.94
Adjusted for above plus co-morbidities[b]	0.88	0.84	0.92
Adjusted for above plus interventions in place[c]	0.88	0.84	0.92
PEA, fully adjusted for above variables	0.91	0.85	0.97
Asystole, fully adjusted for above variables	0.84	0.78	0.90
Survival with good neurologic function			
Unadjusted outcome	0.70	0.61	0.79
Adjusted for temporal trends and hospital	0.67	0.59	0.77
Adjusted for above plus age, sex, rhythm type, event location, and event characteristics[a]	0.62	0.53	0.73
Adjusted for above plus co-morbidities[b]	0.68	0.57	0.81
Adjusted for above plus interventions in place[c]	0.67	0.57	0.80

Abbreviations: OR- odds rato.

[a]Event characteristics adjusted for in the model were weekend, night, witnessed, presence of a hospital-wide arrest response team, and causes of arrest that occurred in >1% of events.

[b]Includes number of co-morbidities, illness category, and pre-existing conditions from Table 1.

[c]Includes number of interventions and all interventions in Table 1 except “assisted or mechanical intervention,” which was omitted due to significant collinearity with invasive airway.

Table 5

End of Life Care

	White	Black	p
End of Life Care/Discussion			
Time to DNAR, median (Q25–75), hrs	7.7 (1.4–56.3)	12.4 (2.5–74.9)	<0.001
DNAR declared prior to death	16822 (44.5)	4852 (38.3)	<0.001
Life support withdrawn if declared DNAR	8652 (31.4)	2235 (24.8)	<0.001
Reason Resuscitation Ended if Patient Died			<0.001
Deemed futile	23418 (41.0)	8413 (43.7)	
Advanced Directive	3995 (7.0)	1329 (6.9)	
Restrictions by Family	584 (1.0)	106 (0.6)	

All results shown as n (%) unless otherwise indicated. Abbreviations: DNAR- Do Not Attempt Resuscitate.