



## Correspondence



## Mortality in young adults following out-of-hospital cardiac arrest: Evidence from two nationwide propensity-matched cohorts in the United States a decade apart

To the Editor,

There have been significant improvements in the care of out-of-hospital cardiac arrest (OHCA) patients in the past decade [1–4]. Despite improving outcomes in the past decade, the overall OHCA-related mortality and disease burden among survivors measured by disease adjusted life years (DALYs) still remains high in the United States [2]. Adult patients demonstrate poor outcomes following OHCA. However, the literature remains limited regarding OHCA in young population. An improvement in outcomes of OHCA in this age group with more targeted clinical data and interventions can directly translate to economic benefit to healthcare infrastructure. To examine the outcomes of OHCA in the young adults across a decade, we selected two propensity-score matched nationwide cohorts in the US a decade apart, from 2007 and 2017.

We sought to assess the weighted data from the National Inpatient Sample which is sponsored by HCUP and maintained by AHRQ [5]. The NIS encompasses a stratified sample of 20% nonfederal US community hospitals, which is demonstrative of approximately 95% of the US population. When weighted, the NIS dataset provides nationwide estimates of over 35 million hospitalizations annually. The study was exempt from the institutional review board approval in view of de-identified database.

We identified all young adults aged 18–44 years primarily admitted for OHCA in 2007 and 2017 using relevant ICD-9 CM (427.5, 427.41, 427.42)/ICD-10 diagnostic codes (I46, I46.2, I46.8, I46.9, I49.01, I49.02) as principal discharge diagnoses. The age group 18–44 years for the US cohort used in our study was selected based on the young age group defined in previous studies on OHCA from different countries [6–9]. We then performed a propensity score matching using 1:1 near neighbor match method with a caliper width of 0.2. To account for potential confounding factors, the model was adjusted for sociodemographics including age, sex, race, median household income quartile, payer status, type of admission (non-elective/elective), hospital level characteristics and traditional cardiovascular risk factors (hypertension, hyperlipidemia, diabetes, smoking and obesity). Primary endpoints were all-cause in-hospital mortality and associated sex and race based disparities across the two cohorts. Secondary outcomes were disposition of patients and median length of hospital stay. Categorical and continuous data were compared using Chi-square test and Mann Whitney U test, respectively and reported data in terms of numbers/percentages for categorical data and median with interquartile range for continuous data. A two-tailed  $p < 0.05$  was considered a threshold for statistical significance. SPSS v24 (IBM Corp, Armonk, NY, USA) was utilized to complete statistical analyses.

In this study, we compared two OHCA cohorts (706 admissions in 2007 and 720 admissions in 2017) matched for sociodemographic and

cardiovascular comorbidities. Both cohorts were comparable in terms of age at admission, sex, race, non-elective admission, insurance enrollment, hospital regions, whereas 2017 cohort showed more frequent admissions to urban hospitals and fewer admissions to large bed size hospitals compared to the 2007 cohort. There was no significant difference in the frequency of cardiovascular comorbidities including hypertension, hyperlipidemia and diabetes whereas the 2017 cohort showed higher frequency of obesity and smoking after propensity-score matching (Table 1).

In this study, the all-cause mortality in young patients admitted for OHCA remained steady without any significant difference between 2007 and 2017 (31.0% vs. 31.9%;  $p = 0.694$ ) (Table 1). On a further subgroup analysis for sex and race disparity, there was no difference in all-cause mortality among all sex (male: 25.3% vs. 30.7%,  $p = 0.082$ ; female: 38.8% vs. 33.9%;  $p = 0.224$ ) and race groups (White: 25.8% vs. 31.3%,  $p = 0.074$ ; African American: 35.7% vs. 38.5%,  $p = 0.598$ ; Hispanic: 43.8% vs. 38.5%,  $p = 0.520$ ) admitted in 2007 vs. 2017. Median length of hospital stay remains stable (4 days), however; reassuringly, 2017 cohort showed more frequent routine discharges (44.4% vs. 38.4%) and fewer transfers to short-term hospitals (9.0% vs. 13.3%) or other skilled nursing facility or intermediate care facilities (6.9% vs. 12.6%) ( $p < 0.001$ ) as compared to the 2007 cohort.

There are a few limitations of this analysis which should be considered while interpreting the results. Firstly, the NIS is a administrative database so there remains a possibility of over or underdiagnoses of conditions due to coding errors. Due to discrepancy in the OHCA codes in the last few years and to comprehensively include all pertinent discharge records, we have also included codes for ventricular tachyarrhythmias consistent with previous studies [10–12]. However, the methods used to identify cases for inclusion in this study have not been validated in this population before, therefore, it is likely that they are not highly specific for OHCA and might have included some records of inpatient cardiac arrest as well. The database did not reveal follow-up data, lab findings or medication history. Moreover, due to inherent characteristics of the NIS cohort, important confounders could not be accounted for, such as location of arrest, down-time, witnessed status, bystander CPR, defibrillation, and most importantly shockable initial rhythm. These factors are important determinants of survival and may significantly influence the results and conclusions. Nonetheless, the large sample allowed us to evaluate nationally representative cohort of young OHCA admissions a decade apart.

This nationwide population-based analysis of two OHCA cohorts a decade apart establishes that despite intensive preventive efforts and improved therapeutics over the last decade, the survival to discharge has not improved in young OHCA patients in the US. The progress to improved survival rate could be partly hindered due to relatively

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**Table 1**  
Nationwide Propensity-score Matched Cohorts of Young Adults (18–44 years) Admitted for Out-of-Hospital Cardiac Arrest in the United States a Decade Apart: 2007 vs. 2017.

Variables	2007 (N = 706)	2017 (N = 720)	P
Age (years) at admission, median [IQR]	37 [28–42]	38 [31–42]	0.169
Sex			
Male	57.6%	61.1%	0.183
Female	42.4%	38.9%	
Race			
White	60.4%	57.6%	0.241
African American	21.8%	27.1%	
Hispanic	11.3%	9.0%	
Asian or Pacific Islander	1.8%	2.1%	
Non-elective admission	96.4%	96.5%	0.944
Primary expected payer			
Medicare	12.6%	14.6%	0.558
Medicaid	25.9%	24.3%	
Private including HMO	42.4%	41.0%	
Self-pay/No charges/Others	19.1%	20.1%	
Median household income national quartile for patient ZIP Code			
0–25th	27.3%	31.9%	0.295
26–50th	28.1%	25.7%	
51–75th	24.8%	23.6%	
76–100th	19.8%	18.7%	
Bed size of hospital			
Small	7.9%	17.4%	<0.001
Medium	21.3%	29.2%	
Large	70.8%	53.5%	
Location/teaching status of hospital			
Rural	4.2%	4.9%	0.042
Urban non-teaching	39.7%	33.3%	
Urban teaching	56.1%	61.8%	
Region of hospital			
Northeast	18.1%	16.7%	0.201
Midwest	15.6%	12.5%	
South	42.4%	47.2%	
West	23.8%	23.6%	
<b>Comorbidities</b>			
Hypertension (secondary)	26.5%	22.9%	0.118
Hyperlipidemia	13.8%	13.2%	0.763
Diabetes, uncomplicated	7.9%	9.0%	0.458
Diabetes, chronic complications	3.2%	3.5%	0.706
Smoking	17.4%	22.9%	<b>0.01</b>
Obesity	10.9%	15.3%	<b>0.014</b>
<b>Outcomes</b>			
All-cause Mortality			
Overall	31.0%	31.9%	0.694
Male	25.3%	30.7%	0.082
Female	38.8%	33.9%	0.224
White	25.8%	31.3%	0.074
African American	35.7%	38.5%	0.598
Hispanic	43.8%	38.5%	0.520
Disposition of patient			
Routine	38.4%	44.4%	<0.001
Transfers to short-term hospital	13.3%	9.0%	
Other transfers including SNF, ICF	12.6%	6.9%	
Home health care	4.8%	6.3%	
Length of stay (days), median [IQR]	4 [2–9]	4 [2–9]	0.748

$P < 0.05$  indicates statistical significance. IQR = interquartile range, SNF = skilled nursing facility, ICF = intermediate care facility.

increased rates of obesity and tobacco smoking in young OHCA patients admitted in 2017 as compared to 2007. There was no improvement in survival rates between two cohorts across all sex or race groups which warrants a more comprehensive and inclusive approach to find and implement effective ways to curb mortality following OHCA in young population. Controlling two major risk factors in young population, including severe obesity and smoking might help achieving this goal in

the next decade. Concisely, nearly 1 in 3 young OHCA admissions in the US experienced inpatient mortality without improvement in survival rate across two national cohorts selected a decade apart.

### Declaration of Competing Interest

The authors report no relationships that could be construed as a conflict of interest.

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