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Bystander CPR and Long-Term Survival in Older Adults With Out-of-Hospital Cardiac Arrest

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Abstract

BACKGROUND—Most studies on bystander cardiopulmonary resuscitation (CPR) for out-of-hospital cardiac arrest (OHCA) have focused on in-hospital or short-term survival.

OBJECTIVES—The purpose of this study was to examine the association between bystander CPR and long-term survival outcomes for OHCA.

METHODS—Within the Cardiac Arrest Registry to Enhance Survival, we identified 152,653 patients with OHCA ≥65 years of age or older. Using multivariable hierarchical logistic regression, we first examined the association between bystander CPR and in-hospital survival. Then, among those surviving to discharge and linked to Medicare files, we evaluated the association between bystander CPR and long-term mortality over 5 years using multivariable Cox regression.

RESULTS—Overall, 58,464 (38.3%) received bystander CPR. Patients receiving bystander CPR were more likely to have an OHCA that was witnessed, in a public location, and with an initial

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The authors attest they are in compliance with human studies committees and animal welfare regulations of the authors' institutions and Food and Drug Administration guidelines, including patient consent where appropriate. For more information, visit the Author Center.

APPENDIX For supplemental tables please see the online version of this paper.

shockable rhythm. Bystander CPR was associated with a 24% higher likelihood of surviving to hospital discharge (10.2% vs 5.5%; adjusted relative risk: 1.24 [95% CI: 1.19–1.29]; $P < 0.001$), and this survival benefit was similar (interaction $P = 0.24$) for those who were 65 to 74, 75 to 84, and ≥85 years of age. Among patients surviving to hospital discharge (median follow-up of 31 months), bystander CPR was additionally associated with lower long-term mortality vs those without bystander CPR (adjusted hazard ratio: 0.78 [95% CI: 0.73–0.84]; $P < 0.001$), and this benefit was also consistent across age groups (interaction $P = 0.13$).

CONCLUSIONS—In older adults with OHCA, bystander CPR was associated with higher rates of in-hospital survival. This survival benefit was not attenuated by competing mortality risks but increased in magnitude after hospital discharge.

Keywords

cardiac arrest; CPR; older patients; survival

BACKGROUND

An estimated 350,000 persons develop out-of-hospital cardiac arrest (OHCA) annually in the United States,[1] and bystander cardiopulmonary resuscitation (CPR) is a critical link in the chain of survival for OHCA.[2] Although studies have consistently found that bystander CPR is associated with higher survival and better neurological outcomes,[3] most of these studies have assessed survival outcomes only at hospital discharge or at 30 days after hospitalization. Whether bystander CPR is associated with long-term survival is poorly understood but important to establish to ensure that survival gains persist beyond the immediate hospitalization period. Lack of long-term follow-up in OHCA registries, especially in the United States, has been a key limitation that has precluded a formal assessment of long-term survival among those who survive to discharge.

Understanding the association between bystander CPR and long-term survival is particularly critical in older adults, as they are vulnerable to significant neurological and functional disability after OHCA. Moreover, perceived frailty in older adults could affect the delivery of effective CPR (eg, lower compression depth), further diminishing the benefit of bystander CPR when it is initiated. Finally, a high burden of comorbidities and the associated increased risk of death may attenuate the long-term survival benefits of bystander CPR in older adult patients. As half of all OHCA patients in the United States are 65 years or older, demonstrating that survival gains with bystander CPR are durable in older adults is important.

To address this gap in knowledge, we recently linked data from the Cardiac Arrest Registry to Enhance Survival (CARES), the largest OHCA registry in the United States with Medicare files. Leveraging this linked data set with information on long-term vital status, we examined the association between bystander CPR and long-term survival in older adults with OHCA and whether the initial survival gains associated with bystander CPR at hospital discharge are durable or decay over time.

METHODS

DATA SOURCES.

CARES is a prospective, multicenter observational registry of patients with OHCA in the United States. CARES has a catchment area of approximately 167 million residents in 42 states (28 state-level registries with full emergency medical service [EMS] participation and 14 partial state participation). Established by the Centers for Disease Control and Prevention and Emory University, the design of the registry has been previously described.[4,5] Briefly, all patients with a confirmed OHCA and for whom resuscitation is attempted are identified and followed by EMS agencies. Data are collected from 3 sources: 9–1-1 dispatch centers, EMS agencies, and receiving hospitals. Standardized international Utstein definitions for defining clinical variables and outcomes are used to ensure uniformity.[6] A CARES analyst reviews records for completeness and accuracy.[5]

We recently linked CARES data with their Medicare inpatient claims data during the time period of 2013 to 2019 which allowed us to assess patients' long-term survival status if they survived to hospital discharge.[7] The data linkage was based on our prior work linking cardiac arrest registries with Medicare files.[8–10] Briefly, patient-level data in CARES were linked to Medicare files using 5 identifiers: patient age and sex, admission date, admitting hospital (identified using the hospital's American Hospital Association number), and a qualifying International Classification of Diseases-9th Revision or −10th Revision, Clinical Modification diagnosis or procedure code (Supplemental Table 1). We selected Medicare records for the linkage if they included a primary or secondary diagnosis code for cardiac arrest, ventricular fibrillation, or ventricular flutter or a procedure code for CPR, defibrillation, or closed chest massage.

STUDY POPULATION.

Between January 1, 2013, and December 31, 2019, we identified 228,294 patients in CARES with a nontraumatic OHCA who were 65 years of age or older (Figure 1). We excluded 29,810 cases witnessed by EMS personnel (ie, no opportunity to provide layperson bystander CPR) and 45,266 arrests occurring at a nursing home or health care facility, as these have on-site health care professionals. Additionally, we excluded 565 arrests due to drowning or electrocution. Our final study cohort in CARES was comprised of 152,653 OHCAs.

STUDY OUTCOME AND INDEPENDENT VARIABLE.

The study outcomes were 2-fold: in-hospital survival and favorable neurological survival for all CARES patients in the study cohort and, among those surviving to hospital discharge and linked to Medicare denominator files, long-term post-discharge mortality, which was assessed using Medicare denominator files and was complete through December 31, 2019. The accuracy of Medicare data for long-term vital status has been previously shown to by >99% accurate.[11] Cerebral Performance Category (CPC) scores were used to assess neurological status at the time of discharge among survivors as follows: CPC score of 1 denotes mild or no neurological disability, 2 moderate neurological disability, 3 severe neurological disability, 4 coma or vegetative state, and 5 brain death. Favorable neurological

survival (ie, without severe neurological disability) was defined as survival to discharge with a CPC score of 1 or 2.

The exposure of interest was whether layperson bystander CPR was initiated. In CARES, a layperson is defined as any individual not associated with the official 911 response to an OHCA and could include family members, strangers, and off-duty medical providers.

STATISTICAL ANALYSIS.

We conducted a landmark analysis where we first examined the association between bystander CPR and survival to discharge in CARES patients who were 65 years or older and therefore were age-eligible for Medicare enrollment. Then, among those who survived to hospital discharge and were linked to Medicare data, we examined the association between bystander CPR and long-term mortality through 2019.

To examine the association between bystander CPR and survival to discharge, we first compared baseline characteristics between CARES patients with and without layperson bystander CPR using standardized differences, given the large sample size which would make all *P* values statistically significant. A standardized difference of >10% was therefore used to denote a clinically meaningful and significant difference.[12] We then constructed a multivariable hierarchical logistic regression model, with EMS agency as a random effect to account for clustering of survival outcomes within site.[13] We used modified Poisson regression models with robust variance estimates to directly derive relative risk (RR) estimates. In addition to bystander CPR, this model also adjusted for the following variables as fixed effects: age, sex, race, whether the arrest was witnessed, location of arrest (home residence and 6 public locations [commercial building, street or highway, recreational facility, transportation center, industrial place, and other]), etiology of arrest (presumed cardiac, respiratory, drug overdose, hemorrhage, or other), and initially detected cardiac arrest rhythm (asystole, pulseless electrical activity, ventricular fibrillation, pulseless ventricular tachycardia, unknown nonshockable rhythm, and unknown shockable rhythm). To examine if the association between bystander CPR and survival to discharge differed by different older age groups (65–74, 75–84, and ≥85 years of age), we included an interaction term between bystander CPR and age group in this model. Additionally, we evaluated whether the association between bystander CPR and survival differed by location of OHCA by examining a separate interaction between bystander CPR and location of arrest (home vs public location).

Next, to examine the association between bystander CPR and long-term mortality among patients who survived to hospital discharge and were linked to Medicare data, we constructed survival curves by whether bystander CPR was provided using Kaplan-Meier estimates. A multivariable Cox regression model, stratified by hospital site, then evaluated the independent association between bystander CPR and long-term all-cause mortality. This model adjusted for age, sex, race, and a patient's Charlson comorbidity index, which is a weighted index to predict risk of death within 1 year of hospitalization for patients with one of 19 comorbid conditions. Information from the Charlson comorbidity index was obtained from diagnosis codes in the linked Medicare data. As with the outcome of survival to

discharge, we also examined the interaction between bystander CPR and age group for the outcome of long-term mortality.

All analyses were performed using SAS version 9.4 (SAS Institute) and were evaluated at a 2-sided significance level of 0.05. The study was approved by Saint Luke's Hospital's Institutional Review Board.

RESULTS

Of 152,653 Medicare aged persons with OHCA, 58,464 (38.3%) received layperson bystander CPR. There were no differences in age or sex among those with and without bystander CPR, but Black persons with OHCA were less likely to receive bystander CPR (Table 1). Patients with bystander CPR were more likely to have their OHCA in public locations, have a witnessed arrest, and have an initially detected cardiac arrest rhythm that was ventricular fibrillation (which is due, in part, because bystander CPR delays deterioration of a shockable rhythm to a nonshockable rhythm before EMS arrival). The presumed etiology of OHCA was not different between those with and without bystander CPR.

BYSTANDER CPR AND IN-HOSPITAL SURVIVAL.

Patients who received bystander CPR were more likely to achieve sustained return of spontaneous circulation for ≥20 minutes than those without bystander CPR (34.1% vs 28.3%, standardized difference of 12.6%) (Table 2). In turn, patients with bystander CPR had an almost 2-fold higher unadjusted rate of survival to discharge as compared with patients without bystander CPR (10.2% vs 5.5%; standardized difference of 17.5). After adjustment for demographics and cardiac arrest factors, older adults who received bystander CPR had a 24% higher likelihood of survival to hospital discharge (adjusted RR, 1.24 [95% CI: 1.19–1.29]; $P < 0.001$). Higher rates of survival to discharge in those with bystander CPR translated to higher rates of favorable neurological survival: 8.1% vs 3.7%, standardized difference of 18.6. The higher rate of survival to discharge among those with bystander CPR was consistent for those who were 65 to 74, 75 to 84, and ≥85 years of age (interaction P value of 0.24) (Table 3). However, although bystander CPR increased the likelihood of survival to discharge for OHCAs at home and in public locations, the association was stronger for OHCAs occurring in public (interaction $P < 0.001$).

BYSTANDER CPR AND LONG-TERM SURVIVAL.

Among the 11,202 patients surviving to hospital discharge, 5,340 were successfully linked to Medicare files (2,929 [54.9%] with bystander CPR and 2,411 [45.1%] without bystander CPR). Patients who were linked and not linked to Medicare files were similar in patient and cardiac arrest characteristics, as well as rates of favorable neurological survival (Supplemental Table 2). Among patients linked to Medicare files, a comparison of baseline characteristics of survivors who received and did not receive bystander CPR is shown in Table 4. Over a median follow-up of 31 months of follow-up (with up to 5 years of follow-up), patients who received bystander CPR had lower rates of long-term mortality than those without bystander CPR with an unadjusted hazard ratio of 0.67 (95% CI: 0.62–0.72, Figure

2). After adjustment for baseline differences between patient groups, long-term mortality was lower for patients who received bystander CPR than those without bystander CPR (adjusted hazard ratio, 0.78 [95% CI: 0.73–0.84]; $P < 0.001$). The lower rate of long-term mortality among those with bystander CPR was consistent among those who were 65 to 74, 75 to 84, and ≥85 years of age (interaction $P = 0.13$) and for OHCAs occurring at home and in public locations (interaction $P = 0.55$) (see Table 3). When converted to an outcome of long-term survival, patients who survived to hospital discharge and received bystander CPR had a 28% higher likelihood of long-term survival (adjusted hazard ratio for survival of 1.28 [95% CI: 1.18–1.38, $P < 0.001$) (Central Illustration).

DISCUSSION

In a large U.S. registry of OHCA, we found that bystander CPR was associated with a 24% higher likelihood of surviving to hospital discharge. Importantly, the survival gain associated with bystander CPR did not decay over time through up to 5 years of follow-up. In fact, over a median follow-up of months, older adult survivors of OHCA who received bystander CPR had an additional 28% higher likelihood of long-term survival. Collectively, our findings highlight that bystander CPR is associated with higher survival even among persons aged 65 years and older, and these survival gains remained durable over the long-term despite competing risks for mortality due to older age.

Although bystander CPR has been shown to be associated with higher survival, most studies have examined in-hospital or short-term survival. To date, only a handful of studies have evaluated the impact of bystander CPR on long-term survival. One such study from the Danish OHCA registry examined 1-year survival among 2,855 persons with OHCA and found that bystander CPR in cardiac arrest survivors was associated with a 30% lower risk of 1-year mortality although the 95% confidence interval for this outcome was wide (8.6% for bystander CPR vs 15.5% for no bystander CPR; adjusted RR of 0.70 [95% CI: 0.50–0.99]).[14] A second study from King County, Washington of 4,448 patients with OHCA reported higher 5-year survival rates among those who received bystander CPR (14.3% vs 8.7%; $P < 0.001$).[15] Given high levels of CPR proficiency among citizens in Denmark and King County, however, it has remained unclear whether the strong association between bystander CPR and long-term survival are generalizable to the broader U.S. population of cardiac arrest victims. We extend the findings of these prior studies and found that bystander CPR was associated with a higher rate of both short-term and long-term survival in a large representative sample of OHCA in the United States. Additionally, we focused our analyses on older adult patients with OHCA and found that survival gains from bystander CPR over time were not affected by competing mortality risk.

A prior systematic review suggests that bystander CPR is associated with a 2.4-fold higher odds of survival to discharge for non-witnessed OHCAs.[3] In our study of older adults with OHCA, bystander CPR was associated with a smaller 24% higher likelihood of survival to discharge. The reasons for the smaller association between bystander CPR and survival in older adults could be due to these patients' higher perceived frailty to bystanders and resultant delivery of chest compressions that were shallower, a higher propensity for irreversible anoxic brain injury in older adult patients during a cardiac arrest, and/or

more severe comorbidities that partly attenuated survival gains associated with bystander CPR. We did not have data to determine why the association between bystander CPR and in-hospital survival was less robust in older adults than in other studies. However, we found that the survival benefit among older adults with bystander CPR did not attenuate over time, but in fact appeared to increase through 5 years of follow-up. This increase in survival over time may be mediated, in part, by higher rates of favorable neurological survival at hospital discharge among those who received bystander CPR. Our findings therefore underscore the importance of this link in the chain of survival in older adult patients with OHCA. Notably, our interaction analyses suggest that the association of bystander CPR with higher survival was consistent in all older adult age groups—a point that should be reinforced in CPR training for layperson bystanders, first responders, and medical personnel.

STUDY LIMITATIONS.

Our study has some limitations. First, CARES does not collect detailed data on the quality of CPR administered by bystanders. If CPR quality from bystanders in older adults was lower than those provided by bystanders in the general population, it is possible that our estimates between bystander CPR and survival outcomes in older adults were conservative. Moreover, data on duration of resuscitation and other measures of resuscitation quality were not available. Second, because most patients with OHCA die before hospital admission, information on comorbidities and frailty was not available for the analyses on in-hospital survival and there may have been unmeasured confounding between patients who received and did not receive bystander CPR. However, the Charlson comorbidity index was available for patients who survived to hospital discharge and were linked to Medicare files, and our long-term survival analyses adjusted for comorbidity burden. Third, our analyses may not be generalizable to regions not covered by the CARES registry. Nonetheless, CARES currently has a catchment area of more than half of all U.S. residents and it is unlikely that the association between bystander CPR and survival would be very different in regions of the United States not covered by CARES.

CONCLUSIONS

In older adults with OHCA, bystander CPR was associated with higher rates of in-hospital survival. This survival benefit was not attenuated by competing mortality risks but increased in magnitude after hospital discharge.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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ABBREVIATIONS AND ACRONYMS

CARES	Cardiac Arrest Registry to Enhance Survival
CPC	Cerebral Performance Category
CPR	cardiopulmonary resuscitation
EMS	emergency medical service
OHCA	out-of-hospital cardiac arrest
RR	relative risk

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PERSPECTIVES

COMPETENCY IN MEDICAL KNOWLEDGE:

OHCA is common in the United States, and layperson bystander CPR increases the likelihood of surviving to hospital discharge. In older adults with OHCA, the survival benefit with bystander CPR is not limited to in-hospital survival but persists for up to 6 years after discharge.

TRANSLATIONAL OUTLOOK:

National efforts to increase rates of layperson bystander CPR should emphasize that this intervention not only improves immediate survival for an OHCA but that its benefits are durable, even in older adults.

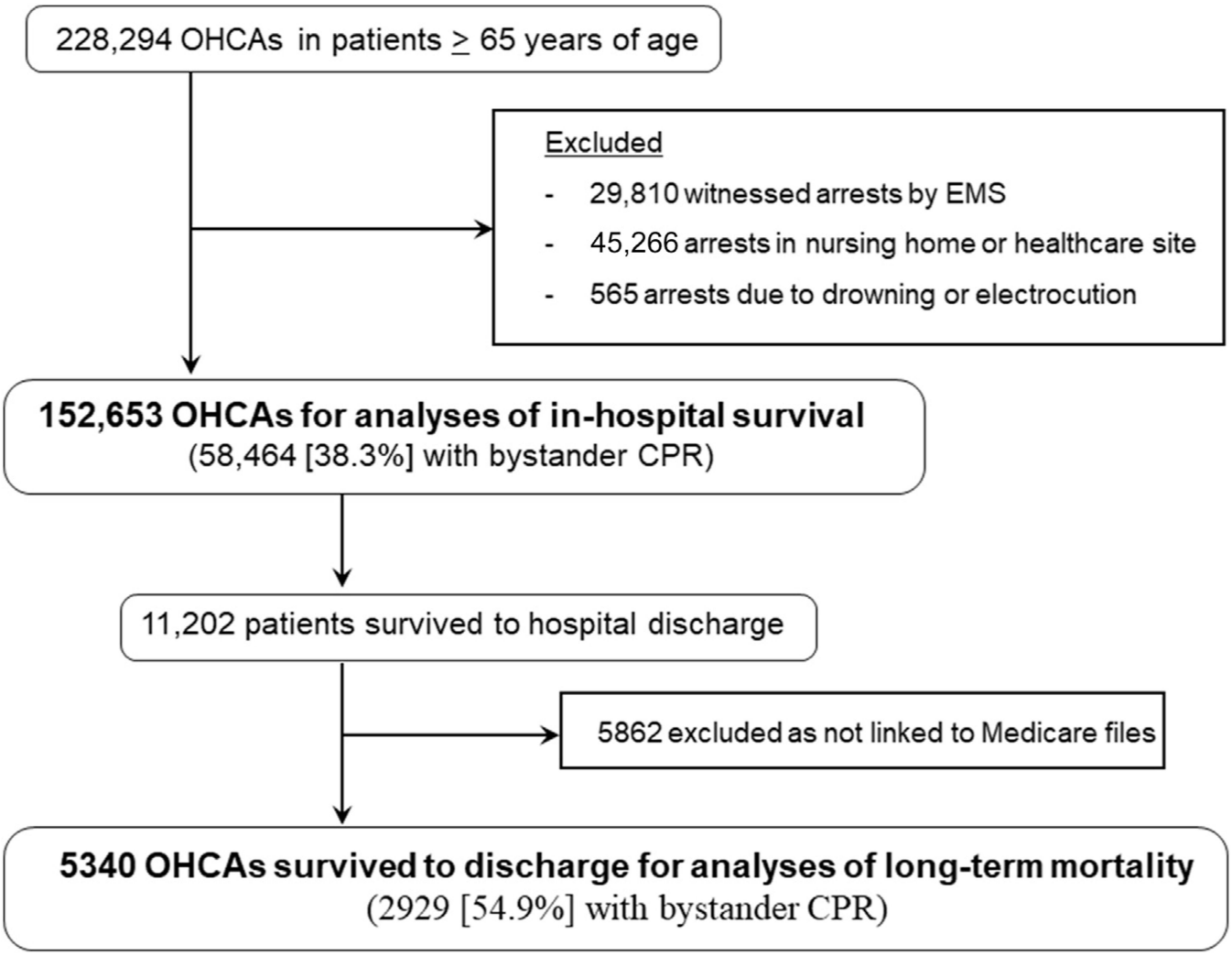


FIGURE 1. Definition of the Study Cohort

CPR = cardiopulmonary resuscitation; EMS = emergency medical service; OHCA = out-of-hospital cardiac arrest.

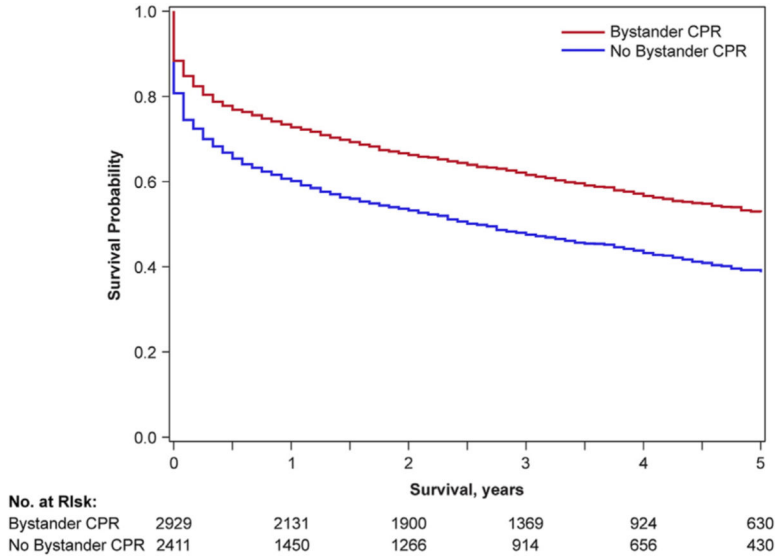
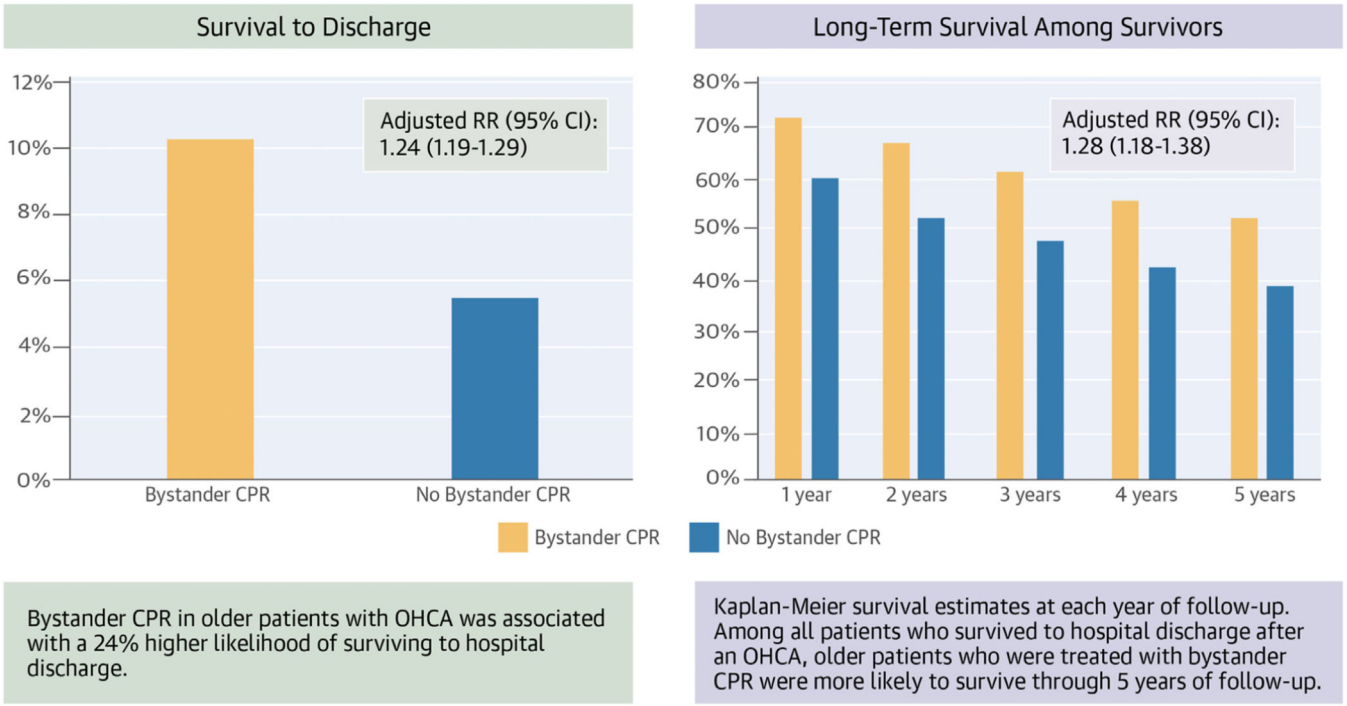


FIGURE 2. Long-Term Survival in Cardiac Arrest Survivors by Bystander CPR Treatment
CPR = cardiopulmonary resuscitation.



CENTRAL ILLUSTRATION. Association Between Bystander CPR and Short- and Long-Term Survival for OHCA

The left sided panel shows that bystander CPR in older adults with OHCA was associated with a 24% higher likelihood of surviving to hospital discharge. The right sided panel shows Kaplan-Meier survival estimates at each year of follow-up. Among all patients who survived to hospital discharge after an OHCA, older adult patients who were treated with bystander CPR were more likely to survive through 5 years of follow-up. CPR = cardiopulmonary resuscitation; OHCA = out-of-hospital cardiac arrest; RR = relative risk.

TABLE 1

Comparison of Patients With OHCA by Whether Bystander CPR was Provided

	Yes (n = 58,464)	No (n = 94,189)	Standardized Difference, %[a]
Age group, y			
65–74	28,416 (48.6)	41,977 (44.6)	8.1
75–84	19,390 (33.2)	32,340 (34.3)	2.5
≥85	10,658 (18.2)	19,872 (21.1)	7.2
Female	21,761 (37.2)	36,963 (39.2)	4.2
Race/ethnicity[b]			
White	31,683 (54.2)	47,116 (50.0)	8.4
Black	8,294 (14.2)	18,975 (20.2)	15.9
Hispanic	2,901 (5.0)	4,936 (5.2)	1.3
Asian	2,003 (3.4)	3,004 (3.2)	1.3
Native American	202 (0.4)	303 (0.3)	0.4
Unknown	13,381 (22.9)	19,855 (21.1)	4.3
Location type			
Home	48,168 (82.4)	84,145 (89.3)	20.0
Public location type			
Commercial building	5,624 (9.6)	4,507 (4.8)	18.9
Street or highway	2,369 (4.1)	4,413 (4.7)	3.1
Recreational facility	1,439 (2.5)	601 (0.6)	14.8
Transport center	398 (0.7)	196 (0.2)	7.1
Industrial place	183 (0.3)	120 (0.1)	4.0
Other	283 (0.5)	207 (0.2)	4.5
Witnessed arrest	34,002 (58.2)	39,501 (41.9)	32.9
Etiology of arrest			
Presumed cardiac	54,428 (93.1)	86,731 (92.1)	3.9
Respiratory	3,216 (5.5)	5,890 (6.3)	3.2
Drug overdose	105 (0.2)	281 (0.3)	2.4
Hemorrhage	161 (0.3)	283 (0.3)	0.5
Other	554 (0.9)	1,004 (1.1)	1.2
First monitored rhythm			
Asystole	26,521 (45.4)	48,158 (51.1)	11.6
Pulseless electrical activity	11,140 (19.1)	20,955 (22.2)	7.9
Unknown unshockable rhythm	5,489 (9.4)	9,387 (10.0)	2.0
Ventricular fibrillation	10,930 (18.7)	11,271 (12.0)	18.8
Ventricular tachycardia	788 (1.3)	876 (0.9)	3.9
Unknown shockable rhythm	3,596 (6.2)	3,542 (3.8)	11.0

Values are n (%).

[a] A standardized difference of >10% denotes a significant difference.

[b] Race and ethnicity as assessed in the CARES registry.

CPR = cardiopulmonary resuscitation; OHCA = out-of-hospital cardiac arrest.

TABLE 2

Unadjusted Rates of Survival Outcomes by Whether Bystander CPR Was Provided

	Yes (n = 58,464)	No (n = 94,189)	Standardized Difference, %[a]
Sustained ROSC	19,964 (34.1)	26,671 (28.3)	12.6
Survived to discharge	5,983 (10.2)	5,219 (5.5)	17.5
Favorable neurological survival[b]	4,732 (8.1)	3,510 (3.7)	18.6

Values are n (%).

[a]A standardized difference of >10% denotes a significant difference between the bystander CPR groups.

[b]Survival to discharge with a Cerebral Performance Category score of 1 or 2, denoting that patient had survival without severe neurological disability.

CPR = cardiopulmonary resuscitation; ROSC = return of spontaneous circulation.

TABLE 3

Association Between Bystander CPR and Outcomes by Age Group and Location of OHCA

Survival to Discharge[a]	Relative Risk (95% CI)	Interaction *P* Value
Overall cohort	1.24 (1.19–1.29)	NA
By age group, y		0.24
65–74	1.34 (1.26–1.42)	
75–84	1.28 (1.18–1.39)	
≥85	1.10 (0.97–1.25)	
By location of arrest		<0.001
Home	1.19 (1.13–1.26)	
Public location	1.60 (1.47–1.75)	
Long-Term Mortality[b]	**Hazard Ratio (95% CI)**	**Interaction**
Overall cohort	0.78 (0.73–0.84)	NA
By age group, y		0.13
65–74	0.74 (0.67–0.83)	
75–84	0.80 (0.71–0.91)	
≥85	0.91 (0.75–1.12)	
By location of arrest		0.55
Home	0.80 (0.69–0.92)	
Public location	0.84 (0.77–0.91)	

The association between bystander CPR and survival to discharge and long-term mortality was consistent across age groups, as both interaction analyses were not significant. In contrast, bystander CPR was associated with a larger likelihood of survival to discharge for OHCAs in public locations, while the association between bystander CPR and long-term mortality was similar for home and public OHCAs.

[a]Adjusted for bystander CPR, age, sex, race, whether arrest was witnessed, location and etiology of arrest, initially detected cardiac arrest, and the specified interaction group.

[b]Adjusted for bystander CPR, age, sex, race, location of arrest, a patient's Charlson comorbidity index, and the specified interaction group.

CPR = cardiopulmonary resuscitation; OHCA = out-of-hospital cardiac arrest.

table 4

Comparison of OHCA Patients Who Survived to Hospital Discharge by Whether Bystander CPR Was Provided

	Yes (n = 2,929)	No (n = 2,411)	Standardized Difference, %[a]
Age group, y			
65–74	1,904 (65.0)	1,449 (60.1)	10.2
75–84	799 (27.3)	705 (29.2)	4.4
≥85	226 (7.7)	257 (10.7)	10.2
Female	772 (26.4)	815 (33.8)	16.3
Race/ethnicity[b]			
White	2,231 (76.2)	1,658 (68.8)	16.6
Black	331 (11.3)	467 (19.4)	22.5
Hispanic	146 (5.0)	142 (5.9)	4.0
Asian	101 (3.5)	72 (3.0)	2.6
Native American	20 (0.7)	11 (0.5)	3.0
Unknown	100 (3.4)	61 (2.5)	5.2
Charlson comorbidity index			
0	1,911 (65.2)	1,354 (56.2)	18.7
1	164 (5.6)	157 (6.5)	3.8
2	153 (5.2)	178 (7.4)	8.9
3	125 (4.3)	147 (6.1)	8.3
≥4	576 (19.7)	575 (23.9)	10.2
Location type			
Home	1,565 (53.4)	1,757 (72.9)	41.2
Public location type			
Commercial building	729 (24.9)	341 (14.1)	27.4
Street or highway	262 (9.0)	238 (9.9)	3.2
Recreational facility	254 (8.7)	41 (1.7)	31.8
Transport center	74 (2.5)	21 (0.9)	12.8
Industrial place	21 (0.7)	5 (0.2)	7.5
Other	24 (0.8)	8 (0.3)	6.5
Witnessed arrest	2,518 (86.0)	1,613 (66.9)	46.2
Etiology of arrest			
Presumed cardiac	2,743 (93.7)	2,146 (89.0)	16.6
Respiratory	147 (5.0)	220 (9.1)	16.1
Drug overdose	12 (0.4)	18 (0.8)	4.4
Hemorrhage	3 (0.1)	1 (0.0)	2.3
Other	24 (0.8)	26 (1.1)	2.7
First monitored rhythm			
Asystole	203 (6.9)	336 (13.9)	23.1
Pulseless electrical activity	314 (10.7)	591 (24.5)	36.7
Unknown unshockable rhythm	293 (10.0)	264 (11.0)	3.1

	Yes (n = 2,929)	No (n = 2,411)	Standardized Difference, %[a]
Ventricular fibrillation	1,329 (45.4)	811 (33.6)	24.2
Ventricular tachycardia	103 (3.5)	83 (3.4)	0.4
Unknown shockable rhythm	687 (23.5)	326 (13.5)	25.8

Values are n (%). Characteristics are for patients who survived to discharge and were linked to Medicare denominator files.

[a] A standardized difference of >10% denotes a significant difference.

[b] Race determined through linked Medicare files.

CPR = cardiopulmonary resuscitation; OHCA = out-of-hospital cardiac arrest.