ORIGINAL RESEARCH

Long-Term Outcomes Among Elderly Survivors of Out-of-Hospital Cardiac Arrest

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***Background*—**Most studies on out-of-hospital cardiac arrest have focused on immediate survival. However, little is known about long-term outcomes and resource use among survivors.

***Methods and Results*—**Within the national CARES registry, we identified 16 206 adults 65 years or older with an out-of-hospital cardiac arrest between 2005 and 2010. Among 1127 patients who were discharged alive, we evaluated whether 1-year mortality, cumulative readmission incidence, and follow-up inpatient costs differed according to patients' race, sex, initial cardiac arrest rhythm, bystander delivery of cardiopulmonary resuscitation, discharge neurological status, and functional status (hospital discharge disposition). Overall 1-year mortality after hospital discharge was 31.8%. Among survivors, there were no long-term mortality differences by sex, race, or initial cardiac arrest rhythm, but worse functional status and severe neurological disability at discharge were associated with higher mortality. Moreover, compared with first responders, cardiopulmonary resuscitation delivered by bystanders was associated with 23% lower mortality (hazard ratio 0.77 [confidence interval 0.58–1.02]). Besides mortality, 638 (56.6%) patients were readmitted within the first year, and the cumulative readmission incidence was 197 per 100 patient-years. Mean 1-year inpatient costs were $23 765±41 002. Younger age, black race, severe neurological disability at discharge, and hospital disposition to a skilled nursing or rehabilitation facility were each associated with higher 1-year inpatient costs (*P* for all <0.05).

***Conclusion*—**Among elderly survivors of out-of-hospital cardiac arrest, nearly 1 in 3 patients die within the first year. Long-term mortality and inpatient costs differed substantially by certain demographic factors, whether cardiopulmonary resuscitation was initiated by a bystander, discharge neurological status, and hospital disposition. **(*J Am Heart Assoc*. 2016;5:e002924 doi: 10.1161/JAHA.115.002924)**

Key Words: cardiac arrest • cost • outcomes research • survival

Although there are an estimated 350 000 out-of-hospital cardiac arrests annually in the United States,[1] little is known about long-term outcomes among those surviving to hospital discharge. This is because most prior studies of out-of-hospital cardiac arrest have focused on prehospital and in-hospital survival. Further, the few studies that have examined long-term outcomes[2–6] have primarily examined mortality, been restricted to cardiac arrests as a result of ventricular fibrillation, were conducted more than a decade ago, or typically involved a single region or hospital center, many with small sample sizes. As a result, prior studies among survivors may have limited generalizability and have not examined resource utilization.

In addition to the need to quantify long-term mortality and costs among survivors of out-of-hospital cardiac arrest, it would be important to examine these outcomes in specific patient subgroups. For instance, although prior out-of-hospital cardiac arrest studies have found racial and sex differences for in-hospital survival,[7,8] whether long-term mortality and costs also differ by race and sex among survivors is unknown. Although initiation of cardiopulmonary resuscitation (CPR) by a bystander has been linked to higher rates of in-hospital survival,[9] determining whether it is associated with lower or higher mortality and costs among survivors has potential

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Accompanying Tables S1 and S2 and Figure S1 are available at http://jaha.ahajournals.org/content/5/3/e002924/DC1/embed/inline-supplementary-material-1.pdf

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implications for current public campaigns to increase bystander CPR rates and life-years saved.[10] Finally, because many survivors of out-of-hospital cardiac arrest have neurological and functional disability, defining long-term survival and costs by neurological disability and hospital disposition at discharge would better enable patients and physicians to use this prognostic information for shared decision-making.

Given these gaps in knowledge, we linked data from a large, national out-of-hospital cardiac arrest registry with Medicare claims files and examined long-term mortality, readmission incidence, and cumulative inpatient costs at 1 year among survivors who were discharged after an out-of-hospital cardiac arrest. We examined rates of these outcomes overall, as well as by race, sex, initial cardiac arrest rhythm, bystander administration of CPR, discharge neurological status, and hospital disposition.

Methods

Data Sources and Linkage

Cardiac arrest registry to enhance survival (CARES) is a large, prospective clinical registry of patients with out-of-hospital cardiac arrest in the United States. Established in October 2005 by the Centers for Disease Control and Prevention and Emory University for public health surveillance and continuous quality improvement, the design of the registry has been previously described in detail.[11,12] Briefly, all patients with a confirmed out-of-hospital cardiac arrest (defined as apnea, pulselessness, and unresponsiveness for which CPR was initiated) of presumed cardiac etiology and for whom resuscitation is attempted are identified and followed, including those with termination of resuscitation before hospital arrival. Data are collected from 3 sources that together define the continuum of emergency cardiac care: 911 dispatch centers, emergency medical services (EMS) agencies, and receiving hospitals. Standardized international Utstein definitions for defining clinical variables and outcomes are used to ensure uniformity.[13] The completeness of data submitted to CARES is confirmed during routine data audits, wherein the number of cardiac arrest cases reported to CARES by each participating EMS agency is compared with the number of cardiac arrest cases in the agency's medical records. Finally, a CARES analyst reviews every record for completeness and accuracy.[12]

Based on prior work linking registries with Medicare files,[14,15] we linked CARES patient-level data from October, 1, 2005, through December 31, 2010, with Medicare inpatient files by using 5 identifiers: dates of hospital admission, patient age and sex, admitting hospital (deidentified), and *International Classification of Diseases, Ninth Revision, Clinical Modification* (ICD-9-CM) diagnosis and procedure codes. We selected Medicare records for the linkage if they included a primary or secondary diagnosis code for cardiac arrest (427.5), ventricular fibrillation (427.41), or ventricular flutter (427.42) or a procedure code for CPR (99.60), defibrillation (99.62), or closed chest massage (99.63). For each linked patient, we obtained Medicare denominator and inpatient files from 2005 through 2010.

Study Population

During the study period, a total of 31 881 patients 18 years or older with an out-of-hospital cardiac arrest not occurring in the presence of EMS personnel were enrolled within CARES (Figure 1). We excluded 15 673 patients younger than 65 years who would not be eligible for a match to Medicare files, leaving 16 208 Medicare age-eligible patients. Of these, 3931 survived to hospital admission (4014 had terminated resuscitations outside the hospital and 8263 in a hospital emergency department). By using the method just described, we linked 2206 (56.1%) of these hospitalized patients to Medicare claims data. The reasons for nonlinkage to Medicare data occurred when a patient (1) was admitted to a non-Medicare hospital (eg, Veterans Administration hospital), (2) had insurance other than fee-for-service Medicare, (3) was admitted to a hospital with few registry patients (thus precluding a unique match), or (4) lacked a qualifying ICD-9-CM diagnosis or procedure code for cardiac arrest in the Medicare files. Patients who were and were not linked to Medicare files had similar demographic and clinical characteristics (Table S1). Finally, as we were interested in examining outcomes among survivors, we excluded 1079 patients who died during the index hospitalization for their cardiac arrest. The final study cohort consisted of 1127

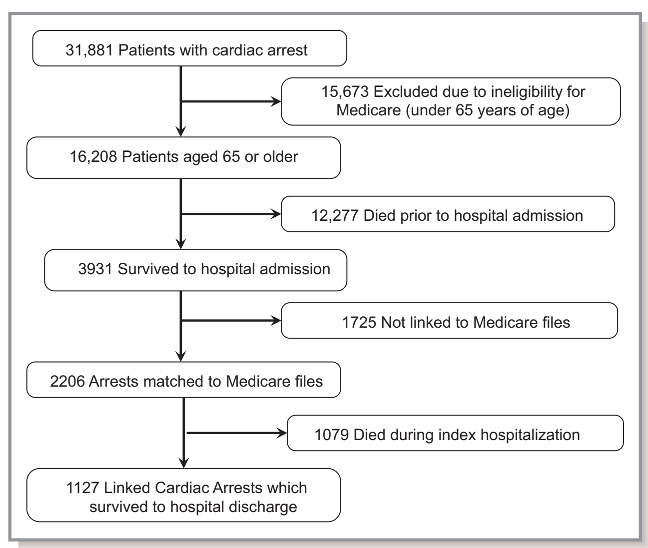


Figure 1. Definition of the study cohort.

patients who survived to hospital discharge after an out-of-hospital cardiac arrest.

Study Outcomes

The outcomes of interest were long-term mortality, cumulative readmission rate, and follow-up inpatient costs at 1 year after discharge from the index hospitalization. Information on vital status was obtained from the Medicare denominator files and on readmissions and inpatient costs from the Medicare inpatient files.

Statistical Analysis

Baseline characteristics of the study cohort were described using proportions for categorical variables and means with SDs for continuous variables. We constructed survival curves by using Kaplan–Meier estimates to determine unadjusted rates of mortality. We also computed cumulative readmission incidence rates at 1 year of follow-up. From these rates, the mean number of readmissions per patient-year of follow-up was determined.

Multivariable Cox proportional hazard models were constructed to determine predictors of 1-year mortality. All models were adjusted for age (65–74, 75–84, and ≥85 years), sex, race (white, black, and other), initial cardiac arrest rhythm (ventricular fibrillation, pulseless ventricular tachycardia, asystole, pulseless electrical activity), location of arrest (private residence, public outdoor area, outpatient healthcare facility, and other), whether the arrest was witnessed, who initiated CPR (first responder [police, fire department staff], bystander, or EMS personnel), who first applied an automated external defibrillator, hospital disposition at discharge (home self-care, home with home health care, skilled nursing facility, inpatient rehabilitation care, hospice, and other), and discharge neurological status. The last item was assessed by using the Cerebral Performance Category scale, which classifies patients as having mild to no neurological disability, moderate disability, severe disability, or coma or vegetative state.[16] Finally, we adjusted for the primary reason for the initial hospitalization (cardiac arrest, other cardiac, pulmonary, and other), which we determined from ICD-9-CM codes for the principal discharge diagnosis in the Medicare inpatient files.

From the model, we derived risk-adjusted hazard ratios for long-term mortality for the following prespecified subgroups: sex, race, initial cardiac arrest rhythm, who initiated CPR, discharge neurological status, and hospital disposition at discharge. In addition to looking at 1-year mortality, we examined whether subgroup differences persisted beyond 1 year and constructed similar models for 3-year mortality. Last, to place our findings in proper context, we compared mortality rates by using Cox models between our cohort and 2 different Medicare cohorts who survived to discharge matched by age, sex, admitting hospital, and hospitalization year. The first cohort was for any hospitalized Medicare patient, whereas the second was for Medicare patients who required mechanical ventilation (ICD-9-CM procedure codes 96.70, 96.71, and 96.72) during the index hospitalization.

To examine inpatient resource use, we first identified each rehospitalization in the cohort from the linked Medicare inpatient files. Costs for each patient were determined by summing costs for each readmission. We then computed adjusted 1-year cost ratios for the aforementioned prespecified subgroups. To accomplish this, because some patients had no follow-up inpatient costs, we constructed a 2-part model conditional on patients who had follow-up inpatient costs, composed of (1) a logistic regression model predicting the probability of having any follow-up costs[17] and (2) a gamma regression model with a log link for the costs (for those patients with nonzero follow-up costs),[18] with this model adjusted for the same variables as described for the model for mortality mentioned earlier. From the model, we calculated adjusted costs for each reference group (eg, men) by performing 1000 bootstrap samples and computing the mean over these 1000 samples. Adjusted cost ratios and 95% CIs for the comparator strata in each subgroup (eg, women) were then derived by performing 1000 bootstrap samples, with the 2.5th and 97.5th percentile cost ratios defined as the 95% CIs.[19]

Overall, rates of missing data were low, with a missing data rate of ≈7% for both race and discharge neurological status. Patients with missing information on these variables were categorized as "unknown" as a separate dummy variable in our models. For each analysis, we evaluated the null hypothesis at a 2-sided significance level of 0.05 and calculated 95% CIs by using robust standard errors. All analyses were performed by using SAS version 9.2 (SAS Institute) and R version 2.10.0 (R Foundation for Statistical Computing).[20] The institutional review boards of the Duke University Health System and the Mid America Heart Institute approved the study, and the requirement for informed consent was waived by the institutional review board from the Mid America Heart Institute.

Results

Of 1127 survivors of out-of-hospital cardiac arrest, 58.3% were men and 19.5% were of black race; mean age was 75.4±7.5 years (Table 1). Nearly half (46.3%) of survivors had a cardiac arrest caused by a shockable cardiac arrest rhythm of ventricular fibrillation or pulseless ventricular tachycardia. Sixty-one percentage of patients were at home at the time of cardiac arrest, 12% occurred in a nursing home facility, and 14.3% in a public area. Although 70.6% of survivors had an out-of-hospital cardiac arrest that was witnessed, CPR was begun by a nonmedical bystander in only 34.3% of instances

Table 1. Characteristics of Study Cohort

		Status at 1 Year		
	All Patients	Alive	Dead	
	N=1127	n=777	n=350	*P* Value
Age, y, mean±SD	75.4±7.5	74.6±7.2	77.1±7.7	<0.001
Age, y				<0.001
65–74	563 (50.0%)	425 (54.7%)	139 (39.7%)	
75–84	401 (35.6%)	268 (34.5%)	133 (38.0%)	
≥85	163 (14.5%)	84 (10.8%)	78 (22.3%)	
Men	657 (58.3%)	457 (58.8%)	200 (57.1%)	0.61
Race, n				0.27
White	828 (73.7%)	579 (74.8%)	249 (71.3%)	
Black	219 (19.5%)	141 (18.2%)	78 (22.3%)	
Other	76 (6.8%)	54 (7.0%)	22 (6.3%)	
Missing	4	3	1	
Initial cardiac arrest rhythm, n				0.18
Asystole	245 (21.7%)	165 (21.2%)	80 (22.9%)	
Pulseless electrical activity	268 (23.8%)	175 (22.5%)	93 (26.6%)	
Indeteminate unshockable rhythm	93 (8.3%)	61 (7.9%)	32 (9.1%)	
Ventricular fibrillation	367 (32.6%)	259 (33.3%)	108 (30.9%)	
VT or indeteminate shockable rhythm	154 (13.7%)	117 (15.1%)	37 (10.6%)	
Location of arrest, n				0.08
Home	688 (61.0%)	465 (59.8%)	223 (63.7%)	
Nursing home	132 (11.7%)	85 (10.9%)	47 (13.4%)	
Public area	161 (14.3%)	123 (15.8%)	38 (10.9%)	
Hospital or healthcare facility	60 (5.3%)	39 (5.0%)	21 (6.0%)	
Other	86 (7.6%)	65 (8.4%)	21 (6.0%)	
Witnessed arrest, n	796 (70.6%)	554 (71.3%)	242 (69.1%)	0.47
CPR initiated by, n				0.12
First responder	333 (29.5%)	216 (27.8%)	117 (33.4%)	
Bystander	387 (34.3%)	268 (34.5%)	119 (34.0%)	
Responding EMS personnel	407 (36.1%)	293 (37.7%)	114 (32.6%)	
Use of public access AED	320 (28.4%)	232 (29.9%)	88 (25.1%)	0.10
Who first applied AED, n				0.10
First responder	407 (36.1%)	273 (35.1%)	134 (38.3%)	
Responding EMS	650 (57.7%)	448 (57.7%)	202 (57.7%)	
Bystander	70 (6.2%)	56 (7.2%)	14 (4.0%)	
Principal discharge diagnosis, n				<0.001
Cardiac arrest	91 (8.1%)	63 (8.1%)	28 (8.0%)	
Acute myocardial infarction	159 (14.1%)	126 (16.2%)	33 (9.4%)	
Other cardiac diagnosis	241 (21.4%)	163 (21.0%)	78 (22.3%)	
Pulmonary diagnosis	220 (19.5%)	119 (15.3%)	101 (28.9)	
Infection and other diagnoses	416 (36.9%)	305 (39.3%)	110 (31.4%)	

Continued

Table 1. Continued

	All Patients N=1127	Status at 1 Year Alive n=777	Dead n=350	*P* Value
Discharge neurological status, n				<0.001
Mild to no disability (CPC score 1)	555 (52.8%)	444 (60.5%)	111 (34.9%)	
Moderate disability (CPC score 2)	265 (25.2%)	204 (27.8%)	61 (19.2%)	
Severe disability (CPC score 3)	148 (14.1%)	57 (7.8%)	91 (28.6%)	
Coma or vegetative state (CPC score 4)	84 (8.0%)	29 (4.0%)	55 (17.3%)	
Missing	75	43	32	
Discharge destination, n				<0.001
Home self-care	430 (38.2%)	382 (49.2%)	48 (13.7%)	
Home with home health care	162 (14.4%)	131 (16.9%)	31 (8.9%)	
Skilled nursing or intermediate care facility	196 (17.4%)	111 (14.3%)	85 (24.3%)	
Rehabilitation center	235 (20.9%)	143 (18.4%)	92 (26.3%)	
Hospice	90 (8.0%)	4 (0.5%)	86 (24.6%)	
Other nonhome facility	14 (1.2%)	6 (0.8%)	8 (2.3%)	

AED indicates automated external defibrillator; CPC, Cerebral Performance Category; CPR, cardiopulmonary resuscitation; EMS, emergency medical services; VT, ventricular tachycardia.

and bystander deployment of an automated external defibrillator was uncommon (6.2%). At hospital discharge, more than half (52.6%) were discharged home (most without requirement for home health care), 38.3% transitioned to an inpatient skilled nursing or rehabilitation facility, 8.0% went to hospice or another facility, and 1.2% went to other nonhome facilities.

Mortality

Overall mortality after hospital discharge was initially steep (12.7% at 30 days) and then rose more gradually, with a mortality rate of 31.8% at 1 year and 47.2% at 3 years (Figure S1). Among the prespecified subgroups, there were no differences in long-term mortality by race, sex, or initial cardiac arrest rhythm (Table 2). However, compared with a 1-year mortality rate of 11.8% among those discharged home without the requirement of home health services, the risk of dying during the first year was 85% higher among those discharged home with a need for home health care and >4-fold higher among those requiring additional inpatient care at a skilled nursing or rehabilitation facility. Moreover, compared with a 1-year mortality rate of 21.4% among those with mild to no neurological disability at discharge, those with severe neurological disability had a 2-fold increase in long-term mortality, even after adjusting for hospital disposition. Finally, compared with when CPR was initiated by first responders, CPR initiated by bystanders (hazard ratio [HR] 0.77 [95% CI 0.58–1.02]) and EMS personnel (HR 0.57 [95% CI 0.43–0.77]; *P* across groups <0.001) was associated with lower long-term mortality.

Mortality results were similar when we repeated the analyses to examine predictors of 3-year mortality (Table S2). For both 1- and 3-year mortality, there were no significant interactions between any of the subgroups of interest by age group or by sex.

Compared with a matched Medicare cohort of patients hospitalized for any reason, survivors of out-of-hospital cardiac arrest had higher 1-year (31.8% versus 20.4%) and 3-year mortality (47.2% versus 37.6%; HR 1.55 [95% CI 1.35–1.77]; *P*<0.001) (Figure 2). In contrast, compared with a matched Medicare cohort of patients who required mechanical ventilation for other reasons, survivors of out-of-hospital cardiac arrest had lower 1-year (31.8% versus 45.6%) and 3-year mortality rates (47.2% versus 60.7%; HR 0.68 [95% CI 0.60–0.77]; *P*<0.001).

Readmission and Costs

Although 31.8% of patients died within the first year after discharge, there were a total of 2015 readmissions, yielding a 1-year cumulative incidence rate of 197 readmissions per 100 patient-years (95% CI 181–214). Notably, 638 (56.6%) patients were readmitted during the first year, and 279 (24.8%) were readmitted ≥3 times (Figure 3).

During the first year, the mean and median 1-year cost for readmissions for the whole cohort (including those who were not admitted) were \$23 765±\$41 002 and \$7054 (IQR \$0–\$30 751), respectively. There were no differences in inpatient costs by sex, initial cardiac arrest rhythm, or initiator of CPR (Table 3). However, compared with whites (1-year mean

Table 2. One-Year Mortality for Prespecified Subgroups

Variable	Unadjusted 1-Year Mortality	Adjusted HR (95% CI)	*P* Value
Sex			
Women	31.1%	Reference	Reference
Men	32.8%	1.03 (0.82–1.31)	0.79
Race			
White	30.7%	Reference	0.76
Black	36.7%	1.11 (0.84–1.46)	
Other	29.2%	1.01 (0.63–1.61)	
Initial cardiac arrest rhythm			
Asystole	33.1%	Reference	0.39
Pulseless electrical activity	35.5%	1.19 (0.87–1.63)	
Indeteminate unshockable rhythm	35.4%	1.59 (0.99–2.58)	
Ventricular fibrillation	30.2%	1.23 (0.88–1.70)	
VT or indeterminate shockable rhythm	25.0%	1.20 (0.72–2.01)	
Person initiating CPR			
First responder	36.2%	Reference	<0.001
Bystander	31.7%	0.76 (0.57–1.01)	
EMS personnel	28.6%	0.57 (0.43–0.77)	
Discharge neurological status (CPC score)			
Mild to no disability	21.4%	Reference	<0.001
Moderate disability	24.4%	0.71 (0.45–1.10)	
Severe disability	63.1%	2.08 (1.37–3.14)	
Coma or vegetative state	66.2%	2.09 (1.31–3.35)	
Hospital disposition			
Home self-care	11.8%	Reference	<0.001
Home with home health care	19.5%	1.82 (1.15–2.88)	
Skilled nursing or intermediate care	44.8%	4.29 (2.92–6.29)	
Inpatient rehabilitation facility	40.0%	4.23 (2.92–6.12)	
Hospice	96.3%	45.1 (7.31–37.1)	

CPC indicates Cerebral Performance Category; CPR, cardiopulmonary resuscitation; EMS, emergency medical services; HR, hazard ratio; VT, ventricular tachycardia.

inpatient costs of $20 299), black patients incurred nearly twice that rate for inpatient costs during the first year (adjusted cost ratio 1.95, 95% CI 1.55–2.46; $P<0.001$). For patients discharged home, readmission costs for those discharged to an inpatient skilled nursing or rehabilitation care facility were >2-fold higher. Finally, patients with moderate to severe neurological disability at discharge had significantly higher 1-year inpatient costs.

Discussion

Among patients 65 years or older who survived an out-of-hospital cardiac arrest, 1-year mortality was 32%, with the most vulnerable period during the first month after discharge, wherein 40% of deaths occurred during the first year. Despite this, long-term mortality for survivors of out-of-hospital cardiac arrest was substantially lower than that for patients who required mechanical ventilation for other reasons before discharge. Although there were no racial or sex differences in long-term mortality, mortality differed markedly by neurological status at discharge and hospital disposition. Moreover, CPR initiated by bystanders was associated with lower mortality, and the mortality differences among each of these subgroups persisted at 3 years. Readmission during the first year was common, with mean 1-year inpatient costs of ≈$23 000, and costs differed by race, hospital discharge

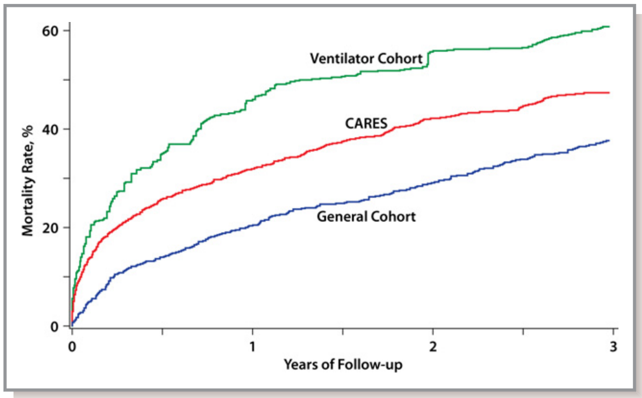
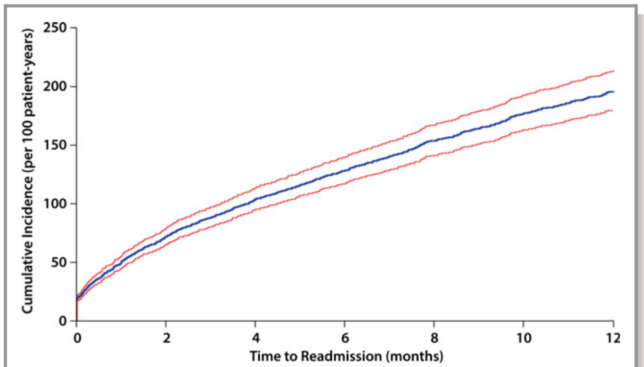


Figure 2. Comparison of long-term mortality with matched medicare cohorts. Survivors of out-of-hospital cardiac arrest had higher mortality during follow-up than patients hospitalized for any reason but lower mortality than patients who required mechanical ventilation during the index hospitalization. CARES indicates cardiac arrest registry to enhance survival.

disposition, and neurological status at discharge. Collectively, our findings highlight that survivors of out-of-hospital cardiac arrest have significant mortality and morbidity risks after hospital discharge and these risks differed based on certain demographic factors, whether CPR was initiated by a bystander, and neurological and functional status at discharge.

Until recently, there has been limited information on the long-term outcomes of survivors of out-of-hospital cardiac arrest. In general, prior studies have been largely restricted to patients with ventricular fibrillation or from communities with highly organized EMS systems. One study from Olmsted County of 79 cardiac arrest survivors with ventricular fibrillation found that the expected 5-year mortality rate was 21%.[3] Another study from Seattle—a metropolitan region with high rates of bystander CPR and a well-organized EMS system—reported a 1-year mortality rate of 18%.[4] A third retrospective study from the Netherlands 2 decades ago reported a 1-year mortality rate of only 12% among 441 survivors of out-of-hospital cardiac arrest,[5] while a more recent study of 95 cardiac arrest survivors from Copenhagen found a 1-year mortality rate of 13%.[6] A fifth study exists for 61 cardiac arrest survivors from >3 decades ago.[2] Our study was able to build on this prior literature by examining outcomes across multiple communities throughout the United States, many of which do not have EMS systems as robust as those in Seattle and Denmark. We evaluated not only mortality but also rates of readmission and inpatient resource use—which, to our knowledge, has not been previously described—and we were able to evaluate predictors of these outcomes given our sample size.



Hospitalizations per Patient	N	% of Cohort
0	489	43.4%
1	206	18.3%
2	153	13.6%
3	86	7.6%
>3	193	17.1%

Figure 3. Cumulative readmission incidence and frequency of readmissions during the first year. There were 197 readmissions per 100 patient years during the first year of follow-up, although 43% of cardiac arrest survivors were not readmitted during this time.

We observed several predictors of 1-year mortality and costs. Although men and patients of black race with out-of-hospital cardiac arrest are known to have higher rates of in-hospital mortality than do women and whites, respectively,[7,8] we found no differences by race or sex in long-term mortality among cardiac arrest survivors, although black survivors had higher inpatient costs than white survivors. Patients with severe neurological disability had both higher mortality (confirming the results of a recent study[21]) and inpatient costs at 1 year. This suggests that renewed efforts are needed to treat both the heart and the brain during acute resuscitation care, as significant neurological disability in a cardiac arrest survivor is not only associated with lower quality of life but also substantially higher postdischarge morbidity and mortality.

A strong and powerful predictor of long-term mortality was functional status, as assessed by hospital disposition in our study. Patients who were able to be discharged independently to their homes had a mortality rate during the first year of only 11.8%, or half the cohort average, while those discharged home with a need for home health services had nearly double this mortality rate. Most notably, patients who required further inpatient care at a skilled nursing facility or rehabilitation site had a mortality rate was >4-fold higher than that of patients discharged independently to their homes.

Finally, we found that cardiac arrest survivors in whom CPR was initiated by a bystander or EMS personnel had lower mortality compared with those in whom CPR was initiated by first responders from police and fire departments. Although we did not have information on time to CPR (as many cases of cardiac arrest are unwitnessed), cardiac arrest patients treated by bystanders likely have shorter time intervals between the onset of cardiopulmonary arrest and when CPR

Table 3. Inpatient Costs at 1 Year, Overall and by Patient Subgroup

	Unadjusted 1-Year Costs	Adjusted Cost Ratio (95% CI)	*P* Value
All patients	\$23 765±\$41 003		
Sex			
Women	\$25 207	Reference	Reference
Men	\$22 086	0.97 (0.80–1.20)	0.38
Race			
White	\$20 299	Reference	Reference
Black	\$36 181	1.95 (1.55–2.45)	<0.001
Other	\$24 213	1.02 (0.66–1.50)	0.43
Person initiating CPR			
First responder	\$26 975	Reference	Reference
Bystander	\$21 557	0.87 (0.70–1.15)	0.82
EMS personnel	\$23 441	0.92 (0.72–1.23)	0.67
Initial cardiac arrest rhythm			
Asystole	\$25 854	Reference	Reference
Pulseless electrical activity	\$26 981	1.10 (0.82–1.55)	0.24
Indeterminate unshockable rhythm	\$23 950	0.88 (0.56–1.41)	0.30
Ventricular fibrillation	\$22 235	0.80 (0.59–1.11)	0.12
Pulseless ventricular tachycardia	\$18 516	0.63 (0.30–1.02)	0.06
Discharge neurological status (CPC score)			
Mild to no disability	\$19 640	Reference	Reference
Moderate disability	\$31 332	1.27 (0.94–1.76)	0.07
Severe disability	\$43 641	1.54 (1.08–2.33)	0.01
Coma or vegetative state	\$32 107	1.54 (1.00–2.48)	0.03
Hospital disposition			
Home	\$14 949	Reference	Reference
Skilled nursing or rehabilitation site	\$41 219	2.75 (2.23–3.33)	<0.001
Hospice	\$1787	0.12 (0.03–0.26)	<0.001

CPC indicates Cerebral Performance Category; CPR, cardiopulmonary resuscitation; EMS, emergency medical services.

is begun, compared with first responders. As a result, cardiac arrest survivors in whom CPR was initiated by a bystander are likely to have less neurological and functional disability at hospital discharge than do those in whom CPR was not initiated by a bystander. Although the link between bystander CPR and lower long-term mortality among cardiac arrest survivors would seem to be intuitive, this association has been reported in only 1 prior study[22] and supports ongoing efforts to broadly disseminate CPR instruction to improve rates of bystander CPR for out-of-hospital cardiac arrest.

Our study has some limitations. First, CARES is a quality-improvement registry. Although it collects data from a diverse group of EMS agencies, our study's overall rates for long-term mortality and inpatient costs in nonparticipating communities may differ, although we have no reason to believe that our subgroup analyses of predictors of these outcomes would be different. Second, we restricted the analysis to Medicare beneficiaries; outcomes of patients younger than 65 years may differ. Third, we excluded patients for whom a CARES record could not be linked to a Medicare hospitalization. This occurred because a patient was admitted to a federal hospital, did not have fee-for-service Medicare insurance, or lacked a qualifying ICD-9 diagnosis or because there were too few cases admitted to a hospital to ensure a unique Medicare match. Nonetheless, excluded patients were similar to patients in the study cohort; therefore, their exclusion was unlikely to significantly bias the results. Third, the CARES registry only recently began collecting data on use of coronary angiography and targeted temperature management for out-of-hospital cardiac arrest patients who survived to hospital admission. These postresuscitation factors may play a role in long-term outcomes among survivors, but we were unable to examine their impact as their inclusion into CARES occurred during the last year of this study sample. Finally, we did not have access to serial assessments of neurological status or quality of life after discharge to allow for a more refined understanding of the trajectory of health status among survivors, nor did we have information about cause of death.

In conclusion, we found that among elderly survivors of out-of-hospital cardiac arrest, nearly 1 in 3 patients die within the first year and readmissions were common. There was no evidence for racial or sex disparities in survival, but long-term mortality differed by whether CPR was initiated by a bystander, patient neurological status at discharge, and hospital disposition.

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Disclosures

None.

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