Published in final edited form as:

Heart. 2018 August ; 104(16): 1356–1361. doi:10.1136/heartjnl-2017-312528.

Selection Bias, Interventions and Outcomes for Survivors of Cardiac Arrest

David J. Wallace, MD, MPH^{a,b,c}, Patrick Coppler, PA-C^b, Clifton Callaway, MD, PhD^c, Jon C. Rittenberger, MD, MS^c, Cameron DeZfulian, MD^{a,b}, Deepika Mohan, MD^{a,b,d}, Catalin Toma, MD^e, and Jonathan Elmer, MD, MS^{b,c}

^aClinical Research, Investigation and Systems Modeling of Acute Illness (CRISMA) Center, University of Pittsburgh School of Medicine, Pittsburgh, Pennsylvania, United States

^bDepartment of Critical Care Medicine, University of Pittsburgh School of Medicine, Pittsburgh, Pennsylvania, United States

^cDepartment of Emergency Medicine; University of Pittsburgh School of Medicine, Pittsburgh, Pennsylvania, United States

^dDepartment of Surgery; University of Pittsburgh School of Medicine, Pittsburgh, Pennsylvania, United States

^eDepartment of Internal Medicine; Division of Cardiology; University of Pittsburgh School of Medicine, Pittsburgh, Pennsylvania, United States

Abstract

Objective—Cardiac catheterization and implantable cardioverter defibrillator (ICD) insertion are increasingly common following cardiac arrest survival. However, much of the evidence for the benefit is observational, leaving open the possibility that biased patient selection confounds the association between these invasive procedures and improved outcome. We evaluated the likelihood of selection bias in the association between cardiac catheterization or ICD placement and outcome by measuring long-term outcomes overall and in a cause-specific approach that separated cardiac and non-cardiac mortality.

Methods—We performed a multivariable survival analysis of a clinical cohort between 2005 to 2013, with follow-up through 2015. We included patients who had out-of-hospital or in-hospital cardiac arrest that survived to discharge, and evaluated the association between cardiac catheterization or ICD insertion and all-cause, cardiovascular and non-cardiovascular mortality.

Results—Among 678 patients who survived cardiac arrest, we observed lower all-cause mortality among patients who underwent cardiac catheterization (adjusted hazard ratio (aHR) 0.40; $p < 0.01$) or ICD insertion (aHR 0.55; $p < 0.01$). However, cause-specific analysis showed that

Address correspondence to: David J. Wallace, Department Critical Care, University of Pittsburgh School of Medicine, 637 Scaife Hall, 3550 Terrace Street, Pittsburgh, PA, 15261. Fax: (412) 647-8060, Phone: (412) 647-7125, wallacedj@upmc.edu.

Disclosures: None

DJW, PC, CC and JE conceptualized and designed the study. DJW, PC and JE carried out the analysis. DJW, PC, CC, JR, CD, DM, CT and JE interpreted the findings. DJW drafted the initial manuscript. PC, CC, JR, CD, DM, CT and JE critically reviewed the draft manuscript and made substantial contributions. All authors approved the final manuscript as submitted.

the benefits of cardiac catheterization and ICD insertion resulted from reduced *non-cardiac* causes of death (cardiac catheterization: aHR 0.24, $p<0.01$; ICD: aHR 0.58, $p<0.01$) while reduced cardiac cause of death was not associated with cardiac catheterization (cardiac catheterization: aHR 0.75, $p=0.33$).

Conclusions—There is evidence of selection bias in the secondary prevention survival benefit attributable to cardiac catheterization for patients who survive cardiac arrest. Observational studies that consider its effects on all-cause mortality likely overestimate the potential benefit of this procedure.

Introduction

Urgent or emergent cardiac catheterization is associated with improved survival after cardiac arrest [1,2], including among patients with non-ST elevation myocardial infarction or non-shockable initial rhythms [3–5]. Consequently, the 2015 American Heart Association Guidelines for post-arrest management recommend that cardiac catheterization is reasonable regardless of presenting rhythm or persistence of post-arrest coma.² Together, these observational data and recommendations are likely responsible for the increasingly frequency of this procedure in post-cardiac arrest management [6]. Rates of implantable cardioverter defibrillator (ICD) insertion after cardiac arrest are also increasing [7,8], similarly based on anticipated reductions in cardiac mortality through secondary prevention [9–13]. However, most of the evidence for the benefit of coronary angiography is observational, leaving open the possibility that patient selection confounds the association between these invasive procedures and outcome (Figure 1).

We examined long-term mortality in a cohort of cardiac arrest survivors to determine whether there was evidence of bias in the selection of patients for cardiac catheterization or ICD insertion. We evaluated long-term outcomes overall and in a cause-specific approach that separated cardiac and non-cardiac mortality.

Methods

We performed our analysis using a detailed prospective clinical registry of cardiac arrest survivors, linked to three large administrative databases. The University of Pittsburgh Institutional Review Board approved all aspects of the study.

Clinical Registry: Post-Cardiac Arrest Service

The University of Pittsburgh has a dedicated Post-Cardiac Arrest Service (PCAS) that provides care for an increasing number of post-arrest patients, now in excess of 300 patients annually, of which approximately 30% survive to discharge. Details of the care we provide across the spectrum of pre-hospital, intensive care unit, acute hospitalization and post-acute rehabilitation have been previously described in detail [14]. As part of our quality improvement and research missions, we maintain a prospective registry of post-arrest patients treated at seven hospitals in southwestern Pennsylvania. This registry includes standard demographic information (age, sex, race, presenting rhythm, arrest location (out-of-hospital vs. in-hospital)), details of care during the index hospitalization including

performance of cardiac catheterization or ICD insertion, and outcomes at hospital discharge including survival, the modified Rankin score, and Cerebral Performance Category (CPC) [15,16]. We performed a manual chart review of all cases where cardiac catheterization was recorded and documented if an intervention (i.e., percutaneous intraluminal stenting or coronary artery bypass grafting) was performed. We carried out this step to provide additional information on the emergent coronary revascularization practice in our system.

We included patients cared for in the hospital after cardiac arrest from 2005 to 2013 and survived to hospital discharge. We limited the analysis to these patients, as it was our objective to evaluate the potential secondary prevention benefits of cardiac catheterization and ICD insertion. We excluded subjects where cardiac arrest occurred secondary to trauma or acute surgical or neurological catastrophe. We further excluded patients who already had an ICD in place prior to the index hospitalization.

Long Term Outcome Assessment: National Death Index

The National Death Index (NDI) is a vital statistics system maintained by the National Center for Health Statistics, a component of the National Vital Statistics System, in the Centers for Disease Control and Prevention. The National Center for Health Statistics employs a variety of data collection methods compile the NDI, which is based on state vital statistics office death reports. The NDI is used extensively for identifying deaths in the United States [17–23] and has modest accuracy for identifying cardiac causes [24]. We obtained these records to identify long-term outcomes and cause of death for patients in the PCAS registry, and linked records as previously described [14]. We categorized causes of death into nine categories (cardiac, infection, malignancy, respiratory, central nervous system, renal, accident or trauma, diabetes, or other) and then into two categories (cardiac and non-cardiac). We considered cardiac causes of death to be: Acute myocardial infarction, including cardiac arrest (I21-I22), All other forms of chronic ischemic heart disease (I20, I25.1-I25.9), All other forms of heart disease (I26-I28, I34-I38, I42-I49, I51), Aortic aneurysm and dissection (I71), Atherosclerosis (I70), Atherosclerotic cardiovascular disease, so described (I25.0), Essential (primary) hypertension and hypertensive renal disease (I10, I12), Heart failure (I50), Hypertensive heart disease (I11), and Other disorders of circulatory system (I80-I99). All other causes of death were considered non-cardiac.

Comorbidities and Outpatient Procedures: Pennsylvania Health Care Cost Containment Council

The Pennsylvania Health Care Cost Containment Council (PHC4) is an independent state agency responsible for maintaining a statewide all payer records of clinical encounters for the purposes of health care quality improvement. We obtained PHC4 records for all inpatient and outpatient procedures from 2005 to 2015. We obtained these records for three reasons: (1) identify cardiac catheterization and ICD insertions occurring after index hospitalization, to avoid exposure misclassification; (2) verify and update comorbid medical conditions for patients included the PCAS registry, to improve the accuracy of the clinical information; and (3) identify International Classification of Diseases (ICD) procedure codes that occurred prior to the index cardiac arrest hospitalization, to validate patient PCAS ICD status. We used social security number, date of birth, and name to link PCAS registry records the PHC4

data. We included records through the end of 2015 to include two years of PHC4 follow-up on the PCAS registry.

Hospital Characteristics: Hospital Cost Report Information System & MedPAR

We obtained hospital characteristics (number of hospital beds, number intensive care unit beds, hospital teaching status (categorizing hospitals as nonteaching if they had no resident trainees, small teaching if the ratio was more than zero and less than 0.2, and large teaching if the ratio was 0.2 or greater) [25], using the Hospital Cost Report Information System information (HCRIS), a database maintained by the Centers for Medicare and Medicaid. We categorized hospitals according to the volume of procedures for cardiac catheterization (using ICD-9P codes 37.22, 37.23, 88.53, 88.54, 00.66, 36.04, 36.06, and 36.07) and volume of ICD insertion (using ICD-9P codes 00.50, 00.51, 37.94–37.96, and 37.80–37.83) using the 2010 Medicare Provider Analysis and Review (MedPAR) file, the final action claim of all hospitalized fee-for-service Medicare beneficiaries. MedPAR is the only national source of hospital claims data and is used extensively for research purposes. We used a threshold of 160 percutaneous coronary interventions [26] and 55 implantable coronary interventions [27] to consider a center “high volume” for each procedure, which we based on prior volume-outcome thresholds. We also categorized hospitals according to the volume of admissions for cardiac arrest (using ICD-9 code 42.75), categorizing hospitals as high volume if they had more than 50 admissions per year in MedPAR [28]. We adjusted these thresholds to account for the age profile of patients included in Medicare.

Analysis

We summarized patient demographics, clinical characteristics, interventions, follow-up, outcomes, and hospital characteristics using descriptive statistics. We described continuous variables with medians and interquartile ranges and categorical variables with frequencies and percentages. We performed an overall description of the cohort and causes of death, and additionally described the cohort when stratified by cardiac catheterization exposure. For the stratified description, we performed comparisons of frequencies and medians using chi squared and ranked-sum tests, as appropriate. We performed multivariable Cox proportional hazard analyses for all-cause, cardiac-cause and non-cardiac-cause of death. These models controlled for age, sex, race, shockable rhythm, favorable CPC score, location of cardiac arrest, and hospital-level volume of cardiac arrest. We selected these variables *a priori* to control for sources of confounding based on our prior analyses reporting significant predictors long-term survival after cardiac arrest [14]. For the continuous variables age and Charlson index, we used a lowess plot against mortality to identify category breakpoints. We performed this step to generate results that were more easily interpreted. We used a hierarchical modeling approach that accounted for clustering post-estimation at the hospital level. We evaluated statistical significance at the alpha 0.05 level.

As recommendations for cardiac catheterization differ following cardiac arrests in the outpatient and inpatient settings, we additionally performed our primary analysis in arrest location stratified cohorts. Although our primary analysis controlled for the location of cardiac arrest, the stratified analysis would directly produce separate measures of

association, facilitating interpretation. We applied the same modeling approach and significance testing as in the primary Cox proportional hazards analysis.

Analysis was performed using STATA version 13.1 (College Station, Texas).

Results

We identified 907 patients who were admitted to the hospital and survived to discharge after sustaining cardiac arrest between 2005 and 2013. We excluded 223 cases where the patient already had an ICD in place and an additional 6 cases where patients were admitted to hospitals that did not perform ICD placement, leaving a final cohort of 678 patients.” All records were successfully linked to records from PHC4 and HCRIS. Slightly more than one third of patients had a cardiac catheterization (n=231, 34.1%) and one eighth had an ICD insertion (n=86, 12.7%) performed during the index hospitalization (Table 1). We reclassified cardiac catheterization in one patient (0.1%) who had an outpatient cardiac catheterization three months after discharge from the index hospitalization and one patient (0.1%) who had an ICD placed three months after discharge from the index hospitalization. Coronary interventions (either percutaneous intraluminal stenting or coronary artery bypass grafting) were performed in 162 of the patients (70.1%) who had cardiac catheterization performed. Characteristics varied between those who had cardiac catheterization and those that did not (Supplemental Table 1). A total of 265 patients had records in the NDI, yielding an overall mortality of 39.1%. Causes of death varied according to cardiac catheterization exposure, with an overall higher rate of cardiovascular cause of death among those who had cardiac catheterization (Supplemental Table 2). All discharges from PHC4 with a designation of death or hospice had agreement with the NDI record.

Hospitals ranged from medium to very large in numbers of total beds and intensive care unit beds (Supplemental Table 3). All hospitals performed cardiac catheterization and 80% (n=4) performed a high annual volume of cardiac catheterization. Similarly, all hospitals performed ICD insertion and 80% (n=4) performed a high annual volume of ICD insertion (the same hospital was low volume for both cardiac catheterization and ICD insertion). Eighty percent of hospitals reported a high number of cardiac arrest cases (the low volume hospital for cardiac arrest had high procedural volume for cardiac catheterization and ICD insertion).

One third of deaths were from cardiac causes (n=89; 34%; Table 2 & Supplemental Table 4). The main non-cardiac causes of death were attributed to infection (n=25; 10%), malignancy (n=24; 9%), and respiratory diseases (n=24; 9%). No causes of death were reported as unknown.

Using Cox proportional hazards regression predicting all-cause mortality, increasing age and Charlson comorbidity index were associated with increased hazard of death, while female sex, out-of-hospital cardiac arrest, favorable discharge CPC, cardiac catheterization, ICD insertion, and high hospital volume of cardiac arrests were associated with decreased hazard of death ($p<0.05$ for all associations; Table 3). In a model predicting *cardiac* cause of death, increasing age and Charlson comorbidity index were associated with increased hazard of

death, while female sex, initial shockable rhythm, favorable CPC, ICD insertion, and high hospital volume of cardiac arrests was associated with decreased hazard of death ($p<0.05$ for all associations; Table 4). Cardiac catheterization was not associated with lower hazard of death (cardiac catheterization: 0.75, $p=0.33$). In a model predicting *non-cardiac* cause of death, increasing age, black race, other race and highest Charlson comorbidity index category were associated with increased hazard of death. In the same model, out-of-hospital cardiac arrest, favorable CPC score, cardiac catheterization, ICD insertion and high hospital volume of cardiac arrests were associated with decreased hazard of death ($p<0.05$ for all associations; Table 5).

The stratified analysis produced similar results to the main analysis. In the cohort of patients with out-of-hospital cardiac arrest, both cardiac catheterization and ICD insertion were associated with decreased hazard of death (aHRs: 0.34 and 0.48, respectively, $p<0.01$ for both; Supplemental Table 5). However, neither procedure was associated with decreased hazard of cardiac death (aHRs: 0.39 and 0.82, $p=0.17$ and 0.49, respectively; Supplemental Table 6), and both were associated with decreased hazard of non-cardiac death (aHRs: 0.29 and 0.28, respectively, $p<0.01$ for both; Supplemental Table 7). In the cohort of patients with in-hospital cardiac arrest, both cardiac catheterization and ICD insertion were associated with decreased hazard of death (aHRs: 0.47 and 0.59, respectively, $p<0.01$ for both; Supplemental Table 8). Cardiac catheterization was not associated with decreased hazard of cardiac death (aHR: 1.13, $p=0.10$; Supplemental Table 9), but was associated with decreased hazard of non-cardiac death (aHR: 0.25, $p<0.01$; Supplemental Table 10). Insertion of an ICD was associated with decreased hazard of death for both cardiac (aHR: 0.25, $p=0.03$; Supplemental Table 9) and non-cardiac causes of death (aHR: 0.76, $p<0.01$; Supplemental Table 10).

Discussion

Using a detailed clinical registry linked to several complementary administrative databases, we identified that selection bias contributes to the observed associations between cardiac catheterization or ICD insertion and reduced mortality among patients discharged alive after cardiac arrest. We observed a strong protective effect for both procedures when considering all-cause mortality. However, in our cause-specific analysis, cardiac catheterization was not associated with a reduction in cardiac death, while both procedures were associated with reduced hazards of *non-cardiac* deaths. The expected findings for secondary benefit from these procedures would be lower rates of cardiac deaths and slightly higher rates of non-cardiac deaths (due to a lower competing cause of death from cardiac deaths) in the intervention cohort. There is no clear mechanism for improved non-cardiac mortality following cardiac catheterization or ICD insertion. These findings suggest that catheterization and ICD insertion were performed on patients who already had better anticipated post-arrest prognosis. Many univariate characteristics and comorbidities differed between the group of patients who had cardiac catheterization and those who did not – supporting the notion that the groups differed in important ways.

We performed several checks on our data. We searched a statewide database to identify cases of cardiac catheterization or ICD insertion that occurred after discharge, to avoid exposure

misclassification (we identified two events, and reclassified both patient exposures). It might have been clinically appropriate, for example, to discharge select patients with a wearable defibrillator as a bridge to myocardial recovery or eventual ICD insertion, or to defer diagnostic coronary angiography until outpatient follow-up. These patients would be expected to still derive a long-term survival benefit from exposure to these procedures, even if they were performed after the index hospitalization. Furthermore, to ensure that patients had an opportunity for exposure (in this case, a procedure), we limited our cohort inclusion to hospitals that performed both procedures, and in fact, 80% of the hospitals performed them at a high annual volume. As we only studied patients who survived the index hospital discharge, minimizing selection bias due to moribund post-arrest clinical status. Our observed overall mortality was consistent with recent estimates in another large cohort [29]. Finally, we performed a manual chart review of all recorded cardiac catheterizations to describe the frequency of coronary interventions. We intentionally did not evaluate coronary angiography with an intervention as an exposure, as it was our interest to evaluate a strategy, and the results of the procedure cannot be known in advance of performing it.

Our analysis has several limitations. We used NDI data to determine cause of death, which likely resulted in some outcome misclassification due to classification inaccuracies. However, in this cohort outcome misclassification would be expected to be non-differential, with errors made in both directions – as supported in a recent review of NDI coding accuracy for cardiac cause of death [24]. The effect of non-differential outcome misclassification is to bias a result towards the null. While this would therefore not affect the validity of our non-cardiac outcome observation, outcome misspecification could have affected our cardiac outcome null finding. Even still, a non-null finding for cardiac outcomes would not have changed the collective interpretation of the results. Although the rate of angiography in our cohort was 34% (which is similar to other cardiac arrest cohorts[30] and higher than the 19.2% catheterization rate reported in a very large OHCA cohort [31]), it was lower than systems that may employ a more aggressive strategy with regard to cardiac catheterization [32]. Despite a rate lower than some systems, we still feel our use of angiography reflects acceptable contemporary practice, and therefore supports the generalizability of the results. Although we were successfully able to identify outpatient procedures, we did not have access to outpatient clinic records. However, clinic visitation would have been difficult to interpret regardless, as a patient may improve their health status through clinic visitation, or clinic visitation may be a marker of declining health. We selected a cohort of patients who survived to discharge, making them potentially different from patients who obtain return of spontaneous circulation, patients who survive 24 hours after cardiac arrest, or patients at other intermediate time-points. We do not feel this diminishes the results, but it is important to note that the population who survives to discharge is, by selection, a subpopulation of all patients who have a cardiac arrest. Finally, we did not have information on the extent of preserved ejection fraction among survivors, which would have allowed us to estimate expected rates of ICD insertion.

Our findings suggest that the observed benefit of cardiac catheterization in survivors of cardiac arrest is *in part* the result of patient selection bias. While there may be real secondary prevention benefits from both procedures, the magnitude of effect is likely smaller than reports from observational research. Randomized-controlled trials are important to evaluate

these interventions and additionally should be powered to detect a smaller effect size than reported in the literature.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

Sources of Financial Assistance: All phases of this study were supported by NIH grants K08HL122478 (Wallace), K12HL109068 (Elmer), DP2 LM012339 (Mohan)

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Key questions

- What is already known about this subject?

Cardiac catheterization appears to confer a mortality benefit in patients who survive cardiac arrest, however the evidence is observational and subject to sources of bias.
- What does this study add?

This study shows that at least some of the reported outcome benefit from cardiac catheterization in patients who survive cardiac arrest is produced by patient selection.
- How might this impact on clinical practice?

While there may be real outcome benefits from cardiac catheterization in this patient group, the magnitude of benefit is likely smaller than reported in observational studies. This has implications for both research purposes (where a magnitude of benefit will drive sample size determinations) and clinical practice.

Figure 1. Selection bias example
In a cohort of cardiac arrest survivors (A), some patients had cardiac catheterization during their hospitalization (B) and others did not (C). Overall, patients who had cardiac catheterization experienced a lower hazard of death (B vs. C). However, when separated by cause-of-death, cardiac catheterization was associated a reduction in non-cardiovascular causes of death (D), rather than a decrease in cardiovascular causes of death (E). This association suggests the presence of at least a component of selection bias in the observed relationship between cardiac catheterization and improved patient outcomes.

Table 1

Patient characteristics, cardiac arrest characteristics, interventions, and outcomes (n=678)

Age, <i>median (IQR)</i>	61 (51 – 72)
Female, <i>n (%)</i>	284 (41.9)
Comorbidities, <i>n (%)</i>	
Congestive heart failure	110 (16.2)
Diabetes	86 (12.7)
COPD	86 (12.7)
Renal disease	60 (8.8)
Peripheral vascular disease	25 (3.7)
Cancer	10 (1.5)
Race, <i>n (%)</i>	
White	549 (81.0)
Black	122 (18.0)
Other	7 (1.0)
Initial shockable rhythm, <i>n (%)</i>	292 (43.1)
Out-of-hospital cardiac arrest location, <i>n (%)</i>	329 (48.5)
Discharge cerebral performance category 1 or 2, <i>n (%)</i>	233 (34.4)
Cardiac catheterization, <i>n (%)</i>	231 (34.1)
Implanted cardioverter defibrillator insertion, <i>n (%)</i>	86 (12.7)
Death, <i>n (%)</i>	
Total	265 (39.1)
Cardiac	95 (14.0)
Non-cardiac	170 (25.1)

Table 2

Causes of death among decedents in National Death Index (n = 265)

Cardiac diseases, <i>n</i> (%)	89 (34)
Infection, <i>n</i> (%)	25 (9)
Malignancy, <i>n</i> (%)	24 (9)
Respiratory diseases, <i>n</i> (%)	24 (9)
Central nervous system diseases, <i>n</i> (%)	14 (5)
Renal failure, <i>n</i> (%)	13 (5)
Accident or trauma, <i>n</i> (%)	11 (4)
Diabetes, <i>n</i> (%)	10 (4)
Other causes, <i>n</i> (%)	55 (21)

Table 3Cox proportional hazard model for **any** cause of death after hospital discharge (n=678)

<u>Variable</u>	<u>Hazard Ratio</u>	<u>95% CI</u>	<u>p-value</u>
Age			
Less than 45 years old	ref	-	-
45 to 75 years old	2.34	(1.57 – 3.48)	< 0.01
More than 75 years old	5.60	(3.42 – 9.16)	< 0.01
Female	0.86	(0.78 – 0.95)	< 0.01
Race			
White	ref	-	-
Black	1.19	(0.95 – 1.51)	0.14
Other	1.52	(0.76 – 3.03)	0.23
Charlson comorbidity index			
0	ref		
1–5	1.86	(1.43 – 2.43)	< 0.01
6+	2.27	(1.83 – 2.82)	< 0.01
Out-of-hospital cardiac arrest	0.65	(0.51 – 0.81)	< 0.01
Initial shockable rhythm	0.92	(0.84 – 1.01)	0.08
Cerebral performance category 1 or 2	0.57	(0.45 – 0.73)	< 0.01
Cardiac catheterization	0.40	(0.35 – 0.45)	< 0.01
Implanted cardioverter defibrillator	0.55	(0.44 – 0.68)	< 0.01
High hospital volume of cardiac arrest	0.38	(0.27 – 0.54)	< 0.01

Table 4Cox proportional hazard model for **cardiac** cause of death after hospital discharge (n=678)

<u>Variable</u>	<u>Hazard Ratio</u>	<u>95% CI</u>	<u>p-value</u>
Age			
Less than 45 years old	ref	-	-
45 to 75 years old	1.86	(1.71 – 2.02)	< 0.01
More than 75 years old	5.43	(4.49 – 6.56)	< 0.01
Female	0.80	(0.64 – 0.99)	0.04
Race			
White	ref	-	-
Black	1.00	(0.63 – 1.58)	0.99
Other	*	*	*
Charlson comorbidity index			
0	ref		
1–5	3.60	(1.32 – 9.80)	0.01
6+	5.40	(1.85 – 15.759)	< 0.01
Out-of-hospital cardiac arrest	0.83	(0.66 – 1.04)	0.11
Initial shockable rhythm	0.69	(0.57 – 0.84)	< 0.01
Cerebral performance category 1 or 2	0.55	(0.40 – 0.76)	< 0.01
Cardiac catheterization	0.75	(0.42– 1.33)	0.33
Implanted cardioverter defibrillator	0.50	(0.36 – 0.69)	< 0.01
High hospital volume of cardiac arrest	0.46	(0.35 – 0.59)	< 0.01

* unable to estimate as there were no cardiac deaths among the 7 patients in this race category

Table 5Cox proportional hazard model for **non-cardiac** cause of death after hospital discharge (n=678)

<u>Variable</u>	<u>Hazard Ratio</u>	<u>95% CI</u>	<u>p-value</u>
Age			
Less than 45 years old	ref	-	-
45 to 75 years old	2.63	(1.38 – 5.00)	< 0.01
More than 75 years old	5.62	(2.42 – 13.06)	< 0.01
Female	0.39	(0.73 – 1.13)	0.41
Race			
White	ref	-	-
Black	1.32	(1.07 – 1.65)	0.01
Other	2.32	(1.30 – 4.12)	< 0.01
Charlson comorbidity index			
0	ref	-	-
1–5	1.48	(0.87 – 2.54)	0.15
6+	1.59	(1.09 – 2.31)	0.02
Out-of-hospital cardiac arrest	0.56	(0.40 – 0.79)	< 0.01
Initial shockable rhythm	1.08	(0.95 – 1.22)	0.23
Cerebral performance category 1 or 2	0.59	(0.44 – 0.79)	< 0.01
Cardiac catheterization	0.24	(0.18 – 0.33)	< 0.01
Implanted cardioverter defibrillator	0.58	(0.41 – 0.83)	< 0.01
High hospital volume of cardiac arrest	0.34	(0.21 – 0.56)	< 0.01