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ORIGINAL INVESTIGATIONS

Long-Term Post-Discharge Risks in Older Survivors of Myocardial Infarction With and Without Out-of-Hospital Cardiac Arrest

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ABSTRACT

BACKGROUND Out-of-hospital cardiac arrest (OHCA) associated with acute myocardial infarction (MI) confers high in-hospital mortality; however, among those patients who survive, little is known regarding their post-discharge mortality and health care use rates.

OBJECTIVES The purpose of this study was to determine 1-year survival and readmission rates after hospital discharge of older MI survivors with and without OHCA.

METHODS Using linked Acute Coronary Treatment and Intervention Outcomes Network Registry-Get With the Guidelines and Medicare data, this study analyzed 54,860 patients with MI who were older than 65 years of age and who had been discharged alive from 545 U.S. hospitals between April 2011 and December 2012. Multivariable models examined the associations between MI-associated OHCA and 1-year post-discharge mortality or all-cause readmission rates. Patients discharged to hospice were excluded, given their known poor prognosis.

RESULTS Following hospital discharge, compared with older MI survivors without OHCA ($n = 54,219$), those with OHCA ($n = 641$, 1.2%) were more likely to be younger, male, and smokers, but less likely to have diabetes, heart failure, or prior revascularization. OHCA patients presented more often with ST-segment elevation myocardial infarction (63.2% vs. 29.6%) and cardiogenic shock (29.0% vs. 2.2%); however, among in-hospital MI survivors, OHCA was not associated with 1-year post-discharge mortality (unadjusted 13.8% vs. 15.8%, $p = 0.17$, adjusted hazard ratio [HR]: 0.89; 95% confidence interval [CI]: 0.68 to 1.15). In contrast, MI survivors with OHCA actually had lower unadjusted and adjusted risk of the composite outcome of 1-year mortality or all-cause readmission than patients without OHCA (44.0% vs. 50.0%, $p = 0.03$, adjusted HR: 0.84; 95% CI: 0.72 to 0.97).

CONCLUSIONS Among older patients with MI who survived to hospital discharge and were not discharged to hospice, those presenting with OHCA did not have higher 1-year mortality or health care use rates compared with those MI survivors without OHCA. These findings show that the early risk of adverse events in patients with OHCA does not persist after hospital discharge, and they support efforts to improve initial survival rates of older patients with MI and OHCA. (J Am Coll Cardiol 2016;67:1981–90) © 2016 by the American College of Cardiology Foundation.

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ABBREVIATIONS AND ACRONYMS

CABG = coronary artery bypass graft surgery

CI = confidence interval

DAOH = days alive out of hospital

HF = heart failure

LVEF = left ventricular ejection fraction

MI = myocardial infarction

NSTEMI = non–ST-segment elevation myocardial infarction

OHCA = out-of-hospital cardiac arrest

STEMI = ST-segment elevation myocardial infarction

Each year, more than 400,000 people have an out-of-hospital cardiac arrest (OHCA) in the United States, with an approximate 10% overall survival rate to hospital discharge among those treated by emergency medical services personnel (1). Up to 80% of sudden cardiac deaths are attributed to underlying coronary disease, particularly among older patients (2,3). Acute myocardial infarction (MI) is a common precipitant of OHCA, with nearly 50% of resuscitated patients with OHCA having an acutely occluded coronary vessel on coronary angiography (4), including more than one-third of patients without ST-segment elevation on their initial electrocardiogram (5). The annual incidence of cardiac arrest for an 80-year-old man is approximately 7 times greater than the incidence for a 40-year-old man (6). Care for patients with OHCA is costly and is directly related to age (7), with predicted in-hospital care costs exceeding $120,000 USD per patient (8). As a result, MI complicated by OHCA remains a growing public health concern in the aging population.

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Although previous studies of patients with OHCA mainly focused on short-term outcomes and showed that the risk of adverse outcomes in the pre-hospital and intra-hospital periods is substantial (9), few studies have specifically examined long-term survival and health care use patterns of older patients with MI and OHCA who were discharged alive from the hospital (10). The long-term prognosis of this population is often assumed to be poor, with conflicting and limited evidence stemming from small single-center studies with highly selected populations (11–14). Decision making is further clouded because randomized clinical trials finding benefit with therapeutic hypothermia enrolled younger patients and excluded very old patients (15–17). Nevertheless, a recent study of in-hospital cardiac arrest in an older Medicare population challenged earlier assumptions, by finding that almost 60% of patients who survived to hospital discharge were alive at 1 year, and more than one-third of these older survivors had not been readmitted (18).

To gain further insight into the long-term outcomes and health care use of older survivors of MI complicated by OHCA after hospital discharge, we compared 1-year mortality rates post-hospital discharge and the composite of 1-year mortality or all-cause readmission rates among MI survivors with and without OHCA. As a confirmatory measure of health care use, we also compared days alive out of hospital (DAOH) within 1 year post-discharge between these groups. Compared with older patients with MI but without OHCA, we hypothesized that those patients with MI complicated by OHCA would have higher rates of 1-year mortality and health care use (readmission and DAOH), even after hospital discharge.

METHODS

DATA SOURCES. The National Cardiovascular Data Registry Acute Coronary Treatment and Intervention Outcomes Network Registry-Get With The Guidelines (ACTION Registry-GWTG) (19) is a voluntary quality improvement registry in the United States that includes consecutive patients admitted to participating hospitals with ST-segment elevation MI (STEMI) or non–ST-segment elevation MI (NSTEMI). This program is sponsored by the American College of Cardiology and the American Heart Association. The National Cardiovascular Data Registry data quality program includes data abstraction training, data

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quality thresholds for inclusion, site data quality feedback reports, independent auditing, and data validation. Auditing of data has demonstrated chart review agreement of >93% (20). At participating sites, this registry was either approved by an Institutional Review Board or considered quality assurance data and was therefore not subject to Institutional Review Board approval on the basis of on individual site determinations. The Duke Clinical Research Institute (Durham, North Carolina) serves as the data coordinating center to analyze de-identified data for research purposes. We linked Centers for Medicare and Medicaid Services claims data through the end of 2012 with patients ≥65 years old in ACTION Registry-GWTG by using the following indirect identifiers: date of birth, sex, hospital identifier, date of admission, and date of discharge. Details describing the linkage process have been previously published (21). Our linkage extended the reach of ACTION Registry-GWTG to assess post-discharge outcomes.

PRE-HOSPITAL AND IN-HOSPITAL DATA DEFINITIONS. Patients with OHCA were identified after evaluation by emergency medical services or emergency department personnel as either: 1) having received attempts at external defibrillation (by lay responders or emergency personnel) or chest compressions by organized emergency medical services or emergency department personnel; or 2) being pulseless, but not having received attempts at defibrillation or cardiopulmonary resuscitation by emergency medical services personnel. The OHCA variable was collected in the ACTION Registry-GWTG starting in April 2011. Cardiogenic shock during the index hospitalization was defined as a sustained (>30 min) episode of systolic blood pressure <90 mm Hg, and/or cardiac index <2.2 l/min/m^2 determined to be secondary to cardiac dysfunction, and/or the requirement for parenteral inotropic or vasopressor agents or mechanical support (e.g., intra-aortic balloon pump, extracorporeal circulation, ventricular assist devices) to maintain blood pressure and cardiac index at levels higher than those specified. In-hospital major bleeding was defined as an absolute hemoglobin drop of ≥4 g/dl (initial to nadir), intracranial hemorrhage, documented or suspected retroperitoneal bleeding, any red blood cell transfusion with a baseline hemoglobin value ≥9 g/dl, or any red blood cell transfusion with a hemoglobin value <9 g/dl and a suspected bleeding event (22). Coronary artery bypass graft (CABG)-related bleeding was not included. Patients with the billing codes for implantable cardioverter-defibrillator insertion, monitoring, revision, removal, and partial insertion or replacement during the index admission were classified as having received an implantable cardioverter-defibrillator. The following International Classification of Diseases-9th Revision (ICD-9) codes were used to identify implantable cardioverter-defibrillators: 37.94, 00.51, 89.49, 37.79, 37.95, 37.96, 37.97, 37.98, and 00.54.

OUTCOME DEFINITIONS. The primary outcome of interest was all-cause mortality at 1 year post-discharge. Cause-specific mortality information was not available from Medicare administrative claims data. A secondary outcome of interest was the composite of all-cause mortality or all-cause readmission within 1 year post-discharge. Transfers to or from other hospitals and discharge to rehabilitation facilities or nursing homes were not classified as readmissions. Hospitalizations for coronary revascularization procedures (percutaneous coronary intervention or CABG) were also not counted as readmissions if they occurred within 60 days of discharge from an index acute MI-related admission without a concurrent diagnosis of heart failure (HF) (ICD-9 codes 428.xx, 425.x, 415.0, 398.91, 402.01, 402.11, 402.91, 404.x1, 404.x3), acute MI (410.x1), unstable angina (411.1), arrhythmia (426.xx, 427.xx, 785.0, 785.1, 99.61, 99.62, 99.69), and cardiac arrest (427.5, 668.1x, 997.1, V12.53, 99.60) (23).

Another secondary outcome was DAOH within 1 year post-discharge, which was calculated for each patient as previously described in detail (24,25). By accounting for both the number and the duration of multiple hospitalizations, DAOH may have some advantages over time-to-event measures; DAOH is a continuous outcome with the potential to add statistical power to detecting treatment differences, and it gives greater weight to mortality (24). The total time spent in the hospital (i.e., “days in hospital”) was computed by adding the length of each hospital stay. This information was obtained through admission and discharge dates on inpatient claims data from the Centers for Medicare and Medicaid Services. If a patient died, then the number of days from the patient’s death to the end of follow-up was assigned as “days dead.” “Days in hospital” and “days dead” were then subtracted from “total potential follow-up time” to arrive at the DAOH for each patient. The total potential follow-up time was determined as the number of days from index hospital discharge until the last day of follow-up by the Centers for Medicare and Medicaid Services.

STATISTICAL ANALYSIS. Baseline characteristics, use of treatments, and interventions during index hospitalization, as well as medications prescribed at discharge, were summarized as median (25th and 75th percentile) for continuous variables and percentages for categorical variables. Differences between patients with MI with OHCA and patients with MI without OHCA were compared using Wilcoxon rank sum tests for continuous variables and chi-square tests for categorical variables.

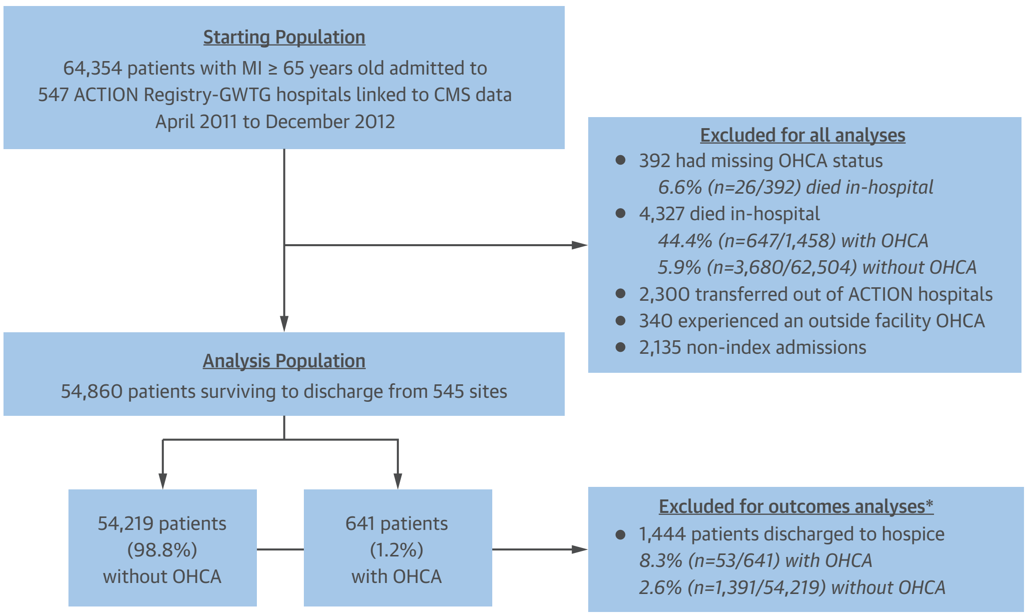
As previously discussed, for the long-term outcomes analyses (1-year mortality and composite of 1-year mortality or all-cause readmission), patients discharged to hospice were excluded (n = 1,444). The rationale for this decision was that the prognosis of these patients is already known to be poor. Kaplan-Meier curves were then generated to estimate the probability of outcomes by OHCA, and the log-rank test was used to assess whether the differences between the outcome curves were statistically significant at $p < 0.05$. To determine the relationship between OHCA and long-term outcomes, multivariable Cox proportional hazards modeling was performed in which robust standard errors were used to account for clustering of patients within hospitals. Covariates used in this model were selected by clinical expert judgment and literature review and included the following: age (year); sex; race; weight (kg); current or recent smoking status; diabetes mellitus; dyslipidemia; previous CABG; previous HF; previous stroke; previous atrial fibrillation or flutter; previous peripheral artery disease; initial systolic blood pressure (mm Hg); initial heart rate (beats/min); HF and cardiogenic shock on first medical contact; initial hemoglobin (g/dl); peak serum creatinine (mg/dl); in-hospital measured left ventricular ejection fraction (LVEF); in-hospital percutaneous coronary intervention; in-hospital CABG; in-hospital shock; in-hospital HF; in-hospital major bleeding; implantable cardioverter-defibrillator implantation during the index admission; cardiac rehabilitation referral on discharge; discharge statin agent; discharge angiotensin-converting enzyme inhibitor or angiotensin receptor blocker; discharge beta-blocker; and hospital transferred in from another acute care facility. Similarly, patients discharged to hospice and not eligible for Medicare Part A and B fee-for-service plans at discharge were excluded from the DAOH analyses. The generalized estimating equations method was used to model DAOH as a proportion of days possible out of 365 days. A logit link was used to reflect the fact that DAOH is bound on 2 sides by 0 and 365 days. Robust empirical variance estimates were used to account for the issue that our data were not necessarily independent binomials and had the potential for clustering of patients within hospitals. The odds ratio for OHCA on the proportion of DAOH is reported along with the 95% confidence interval (CI). We also tested for the potential interaction of LVEF, age, type of MI (STEMI vs. NSTEMI), and OHCA on 1-year mortality and a 1-year composite of mortality or all-cause readmission rates. For all analyses, a p value <0.05 was considered significant. All analyses were performed using SAS version 9.4 (SAS Institute, Inc., Cary, North Carolina).

RESULTS

STUDY POPULATION. There were 64,354 patients with MI who were ≥65 years of age captured between April 1, 2011, and December 31, 2012, from 547 ACTION Registry-GWTG hospitals in the linked database (**Figure 1**). Patients were sequentially excluded if they had missing data for the OHCA field (n = 392), died during the index admission (n = 4,327; 44.4% [647 of 1,458] with OHCA; 5.9% without OHCA [3,680 of 62,504]), were transferred out of ACTION Registry-GWTG hospitals (n = 2,300), or had a cardiac arrest during hospitalization at an outside hospital (n = 340). Finally, for a patient with multiple MI-related admissions during the study period, follow-up was started at the time of the first admission, and registry records for MI-related readmissions were excluded to avoid double counting (n = 2,135). Although our main objective was to describe the long-term outcomes of patients discharged alive from the hospital, for descriptive purposes, we have also included the baseline clinical characteristics of patients who died in hospital (and were subsequently excluded; see earlier text) in Online Table 1. Furthermore, a detailed list of exclusions stratified by OHCA is shown in Online Table 2. After exclusions, we were left with a final study population of 54,860 patients enrolled at 545 ACTION Registry-GWTG hospitals who survived to hospital discharge: 641 with OHCA and 54,219 without OHCA. For the long-term outcomes analyses (1-year mortality, composite of 1-year mortality or all-cause readmission, DAOH within 1 year), patients discharged to hospice were excluded (n = 1,444; 8.3% [53 of 641] with OHCA, 2.6% [1,391 of 54,219] without OHCA) because their prognosis was already known to be poor.

BASELINE CLINICAL CHARACTERISTICS. Among patients with MI who survived the index hospitalization, those with OHCA were younger (median age 73 years vs. 76 years), male (68.6% vs. 55.8%), smokers (20.4% vs. 15.8%), and more likely to have atrial fibrillation or flutter within 2 weeks before admission (15.6% vs. 12.2%) than patients with MI but without OHCA (**Table 1**). MI survivors with OHCA were less likely to have diabetes (28.7% vs. 35.9%), a history of HF (13.7% vs. 17.7%), peripheral arterial disease (10.8% vs. 13.8%), chronic lung disease (14.4% vs. 18.5%), or previous revascularization with

FIGURE 1 Cohort Derivation



The cohort derivation from the initial study population, through exclusions, to the final study population. *Mortality, readmission, and days alive and out of hospital. ACTION Registry-GWTG = Acute Coronary Treatment and Intervention Outcomes Network Registry-Get With The Guidelines; CMS = Centers for Medicare and Medicaid Services; MI = myocardial infarction; OHCA = out-of-hospital cardiac arrest.

either percutaneous coronary intervention (20.0% vs. 26.4%) or CABG (15.6% vs. 19.9%). MI survivors with OHCA were more likely to present to the hospital with STEMI (63.2% vs. 29.6%) and cardiogenic shock at first medical contact (29.0% vs. 2.2%) than MI survivors without cardiac arrest. The clinical characteristics excluding patients discharged to hospice are shown in Online Table 3.

IN-HOSPITAL CLINICAL EVENTS AND MANAGEMENT. Patients with MI with OHCA who survived hospitalization experienced higher rates of in-hospital recurrent or new cardiogenic shock, HF, recurrent cardiac arrest, major bleeding, and red blood cell transfusion (**Figure 2**) ($p < 0.001$ for all comparisons) compared with MI survivors without OHCA. Patients with MI with OHCA were also more likely to receive diagnostic catheterization (89.5% vs. 80.5%; $p < 0.001$) and percutaneous coronary intervention (69.4% vs. 54.8%; $p < 0.001$), but there was no difference in the proportion of patients eventually receiving CABG (9.7% vs. 8.5%; $p = 0.29$). Among patients who had left ventricular function assessed (93.5% of patients overall), those with OHCA had significantly greater left ventricular dysfunction, defined by an LVEF ≤40% (44.8% vs. 29.8%; $p < 0.001$). Patients with OHCA were more likely to receive an implantable cardioverter-defibrillator implantation during hospital admission (9.4% vs. 0.7%; $p < 0.001$).

DISCHARGE DISPOSITION AND INTERVENTIONS. MI survivors with OHCA were more likely to receive in-hospital comfort care measures (8.5% vs. 3.2%) and be discharged to a skilled nursing facility (28.4% vs. 15.6%) or hospice (8.3% vs. 2.6%) ($p < 0.001$ for all comparisons) compared with MI survivors without OHCA. Among eligible patients, significantly more patients with OHCA were referred for cardiac rehabilitation (84.9% vs. 77.3%; $p < 0.001$) (**Table 2**), but there were no differences among groups for patients receiving smoking cessation (97.5% vs. 97.7%; $p = 0.74$), diet modification (95.2% vs. 94.4%; $p = 0.43$), or exercise counseling (86.9% vs. 85.1%; $p = 0.25$) before discharge. More patients with OHCA were prescribed an angiotensin-converting enzyme inhibitor (68.2% vs. 60.2%; $p < 0.001$) or an aldosterone antagonist (9.4% vs. 4.8%; $p < 0.001$) on discharge, but there were no differences in discharge prescriptions for other medications (**Table 2**).

POST-DISCHARGE MORTALITY RATES. Excluding patients discharged to hospice, older patients with MI with OHCA who survived to hospital discharge had long-term survival rates comparable to those in patients with MI but without OHCA. Rates of observed

TABLE 1 Baseline Clinical Characteristics Stratified by Patients With and Without OHCA

	Overall (n = 54,860)	With OHCA (n = 641)	Without OHCA (n = 54,219)
Demographics			
Age, yrs	76 (70, 83)	73 (68, 79)	76 (70, 83)
Male	56.0	68.6	55.8
Nonwhite race	12.9	13.9	12.9
Medical history			
Current/recent smoker (<1 yr)	15.9	20.4	15.8
Hypertension	82.5	76.4	82.6
Dyslipidemia	67.6	64.3	67.6
Currently undergoing dialysis	2.7	3.3	2.7
Chronic lung disease	18.5	14.4	18.5
Diabetes mellitus	35.8	28.7	35.9
Previous MI	27.1	25.3	27.1
Previous HF	17.6	13.7	17.7
Previous PCI	26.4	20.0	26.4
Previous CABG	19.9	15.6	19.9
Previous stroke	11.2	11.2	10.5
AF or AFL (past 2 weeks)	12.2	15.6	12.2
Peripheral arterial disease	13.7	10.8	13.8
At first medical contact			
STEMI diagnosis	30.0	63.2	29.6
HF	19.0	20.3	19.0
Cardiogenic shock	2.5	29.0	2.2

Values are median (25th, 75th percentiles) or %.

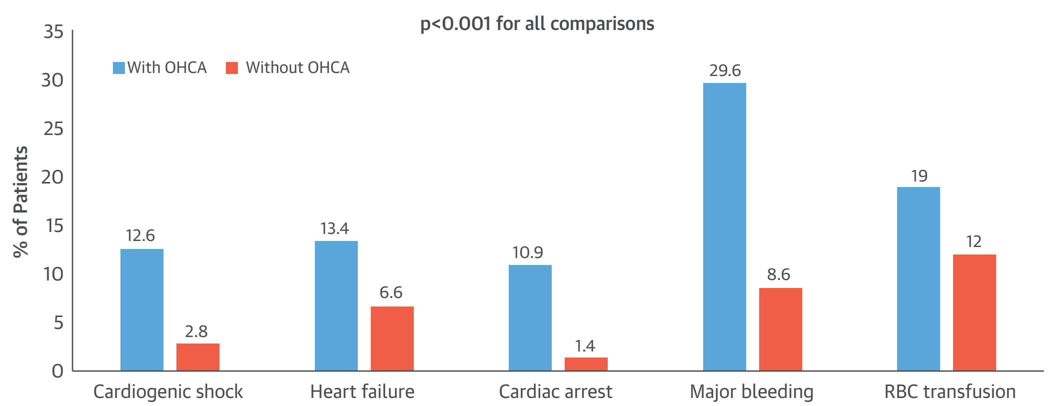
AF = atrial fibrillation; AFL = atrial flutter; CABG = coronary artery bypass grafting; HF = heart failure; MI = myocardial infarction; OHCA = out-of-hospital cardiac arrest; PCI = percutaneous coronary intervention; STEMI = ST-segment elevation myocardial infarction.

1-year mortality post-hospital discharge were not significantly different between MI survivors with OHCA (13.8%; 95% CI: 10.7% to 17.6%) and those without OHCA (15.8%; 95% CI: 15.4% to 16.1%; p = 0.17) (Central Illustration). After multivariable adjustment, OHCA was not independently associated with 1-year mortality rates (adjusted hazard ratio: 0.89; 95% CI: 0.68 to 1.15) among MI survivors. There was also no significant interaction of OHCA and 1-year mortality rates between type of MI (STEMI vs. NSTEMI; p = 0.99), age (p = 0.39), or LVEF (p = 0.41).

RISK OF MORTALITY OR ALL-CAUSE READMISSION. After excluding patients discharged to hospice, overall unadjusted rates of the composite of mortality or all-cause readmission at 1 year were 50.0% (95% CI: 49.5% to 50.5%). Rates of the observed composite of 1-year mortality or all-cause readmission post-hospital discharge were lower among MI survivors with OHCA (44.0%; 95% CI: 39.2% to 49.1%) compared with MI survivors without OHCA (50.0%; 95% CI: 49.5% to 50.6%; p = 0.03) (Central Illustration). After multivariable adjustment, OHCA was independently associated with lower risk of the composite of 1-year mortality or all-cause readmission (adjusted hazard ratio: 0.84; 95% CI: 0.72 to 0.97). There continued to be no significant interaction for this outcome and OHCA by type of MI (STEMI vs. NSTEMI; p = 0.89), age (p = 0.45), or LVEF (p = 0.76).

Median overall DAOH through 1 year was 255 (25th, 75th percentiles: 107, 361) days. There was no significant difference in median unadjusted DAOH between patients with OHCA and patients without OHCA (252 [111, 362] days vs. 255 [107, 361] days; p = 0.81); however, after multivariable adjustment, OHCA was associated with similar DAOH (adjusted odds ratio: 1.37; 95% CI: 1.00 to 1.87).

FIGURE 2 In-Hospital Clinical Events



In-hospital clinical events, including cardiogenic shock, heart failure, cardiac arrest, major bleeding, and red blood cell (RBC) transfusion for older patients with myocardial infarction with and without out-of-hospital cardiac arrest (OHCA) who survived to hospital discharge.

DISCUSSION

To date, studies of patients with OHCA have mainly focused on early outcomes and have shown that the risk of adverse outcomes in the pre-hospital and intra-hospital periods is substantial. Although we found that acute mortality rates were high among patients with OHCA, patients surviving to hospital discharge who are not discharged to hospice have a reasonably good prognosis, with a similar 1-year survival rate and lower rates of health care use than patients with MI but without OHCA.

To our knowledge, this is the largest cohort of patients ever examined for purposes of evaluating the long-term post-discharge outcomes of older patients with MI and concurrent OHCA. After excluding patients discharged to hospice, we were able to evaluate a clinically important population of patients whose long-term prognosis is often unclear. Unlike a recent analysis, which used a population with HF to compare the prognosis of patients discharged alive with in-hospital cardiac arrest (18), we were able to put our findings into context by directly comparing patients with OHCA with patients with MI but without OHCA. Previous OHCA studies focusing specifically on age and outcomes, both in the pre-therapeutic and post-therapeutic hypothermia eras, evaluated only survival to hospital discharge (26–28), 30-day survival (29–31), or longer-term follow-up, but with a smaller cohort of patients with OHCA (12–14,32). Furthermore, our study fills knowledge gaps left by the pivotal clinical trials evaluating hypothermia that included younger patients or excluded older patients altogether (15–17). Finally, we provide insights into the long-term health care use and readmission patterns of this growing demographic, which has been described in published reports on cardiac arrest only among older patients with in-hospital cardiac arrest (33).

We found that older patients with MI with OHCA had an unexpectedly good prognosis once they were discharged from hospital to home or a skilled nursing facility, even though they had greater rates of in-hospital cardiogenic shock, HF, cardiac arrest, major bleeding, and red blood cell transfusion compared with patients without OHCA, a finding consistent with previous reports (9,34–36). We also confirmed results from previous studies that showed a high risk of early adverse events (including in-hospital mortality) among all patients with OHCA who were admitted to the hospital (**Figure 1**, Online Table 1). After excluding these patients who died in hospital or who were discharged to hospice, and after adjustment for important baseline and intra-hospital risk factors of survival, we found no difference in long-term mortality and improved health care use rates among patients with OHCA and concurrent MI. This finding suggests that the greatest risk of adverse events occurs early during hospitalization, but this risk is subsequently mitigated if survival is achieved, a pattern similar to that seen in patients with MI complicated by cardiogenic shock (37). Although we cannot rule out differences in longitudinal care patterns between patients with MI and OHCA and those with MI but without OHCA after discharge (including the impact of discharging more patients with OHCA to skilled nursing facilities), we controlled for differences in discharge intervention including medications, referral to cardiac rehabilitation, and in-hospital implantable cardioverter-defibrillator implantation. Furthermore, our results extend recent emerging evidence from other cohorts demonstrating that patients of all ages with OHCA who survive to discharge have good long-term survival and functional outcomes (26,27,30,38,39), as well as good outcomes among older patients with in-hospital cardiac arrest (18,33).

TABLE 2 Discharge Interventions Stratified by Patients With and Without OHCA*

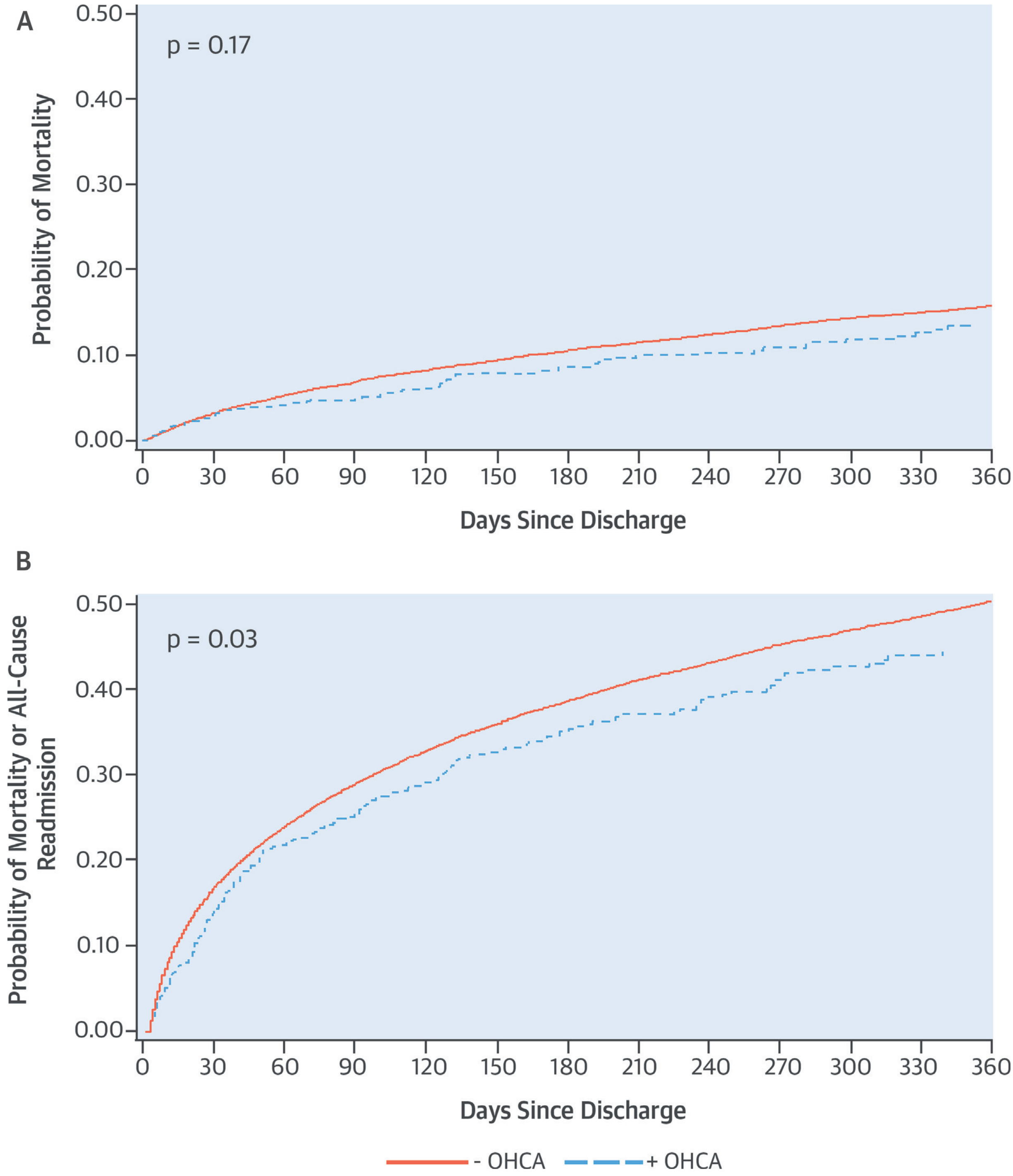
	Overall (n = 54,860)	With OHCA (n = 641)	Without OHCA (n = 54,219)	p Value
Lifestyle				
Cardiac rehabilitation	77.4	84.9	77.3	<0.001
Smoking cessation counseling	97.7	97.5	97.7	0.74
Diet modification counseling	94.4	95.2	94.4	0.43
Exercise counseling	85.1	86.9	85.1	0.25
Medications				
Aspirin	97.8	96.8	97.8	0.14
Clopidogrel	67.4	67.6	67.4	0.89
Prasugrel	9.7	11.4	9.7	0.17
Beta-blocker	96.6	97.7	96.6	0.13
ACE inhibitor	60.2	68.2	60.2	<0.001
ARB	15.3	12.5	15.4	0.07
Aldosterone antagonist	4.8	9.4	4.8	<0.001
Statin	92.6	93.7	92.6	0.31

Values are %. *Among eligible patients (without contraindications to interventions, and not discharged on comfort measures, to hospice, or against medical advice).

ACE = angiotensin converting enzyme; ARB = angiotensin receptor blocker; OHCA = out-of-hospital cardiac arrest.

STUDY LIMITATIONS. First, ACTION Registry-GWTG is a voluntary quality improvement registry of patients admitted with MI; therefore, the registry does not include patients admitted with other causes of cardiac arrest or patients who did not make it alive to an ACTION Registry-GWTG hospital. Nevertheless, the cause of OHCA in older patients is predominately underlying coronary artery disease (including acute coronary syndromes) (2,3), so our study results are still applicable to most older patients with OHCA (40,41). Second, our data permitted only the study of Medicare beneficiaries; therefore, outcomes in older

CENTRAL ILLUSTRATION Kaplan-Meier Mortality Estimates



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(A) Unadjusted cumulative Kaplan-Meier mortality estimates during the 1-year follow-up period among older patients with myocardial infarction with and without out-of-hospital cardiac arrest (OHCA). **(B)** Unadjusted cumulative Kaplan-Meier estimates for the composite of mortality or all-cause readmission during the 1-year follow-up period among older patients with myocardial infarction with and without OHCA.

patients without Medicare or in younger populations may differ. Finally, this dataset does not include granular information on pre-hospital care, including time to return of spontaneous circulation and neurological status on patients' arrival (i.e., comatose), nor does our dataset include the proportion of patients receiving hypothermia and assessments of neurological status or quality of life after discharge. As a result, it is possible that some patients with OHCA had short return of spontaneous circulation times, a finding associated with improved prognosis (30,42), and that could potentially explain the good outcomes for survivors of OHCA. Despite this possibility, OHCA survivors in our cohort had several metrics of increased morbidity consistent with a typical OHCA population requiring a high level of acute care (9), including a higher likelihood of in-hospital complications compared with patients without OHCA. Furthermore, nearly twice as many patients with OHCA were discharged to skilled nursing facilities, a finding suggesting a degree of functional impairment on discharge, which is consistent with previous studies of OHCA (38,39,43).

IMPLICATIONS. First, our data fill an important knowledge gap by providing patients, families, and clinicians a better understanding of the prognosis that can be expected in older patients with cardiac arrest who are discharged alive from the hospital (and not to hospice) after an MI. Second, because our data show that older MI survivors with OHCA have a good prognosis once they are discharged, ongoing efforts to optimize pre-hospital and intra-hospital processes of care should continue with the goal of improving acute survival rates. Recent studies have demonstrated the effectiveness of innovative strategies to improve pre-hospital interventions and outcomes for OHCA. These include implementing public resuscitation training (42) and automated external defibrillator networks (44), use of mobile telephone positioning systems to dispatch lay volunteers (45), and adherence to recommended hospital-based post-resuscitative care guidelines (10,46), including consideration of routine early cardiac catheterization (47). Third, the finding that nearly one-third of patients with OHCA were discharged to a skilled nursing facility suggests that good prognosis exists despite some degree of functional impairment. Finally, our results show that among older patients with MI, OHCA alone was not associated with the composite of 1-year mortality or readmission after hospital discharge.

CONCLUSIONS

We found that after hospital discharge, older patients with MI who were not discharged to hospice and who had OHCA had similar adjusted 1-year mortality and lower health care use rates compared with patients without OHCA. This study shows that the early risk of adverse events in patients with OHCA is attenuated after hospital discharge and supports efforts to improve initial survival rates of older patients with MI and OHCA.

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PERSPECTIVES

COMPETENCY IN MEDICAL KNOWLEDGE: Older patients with acute MI who presented with OHCA and survived to discharge had no higher 1-year mortality or health care use rates than did patients without cardiac arrest.

TRANSLATIONAL OUTLOOK: Future efforts should focus on improving initial survival rates of older patients with MI who have OHCA.

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KEY WORDS cardiac arrest, myocardial infarction, older, prognosis

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