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Characteristics and Outcomes of Patients with Acute Decompensated Heart Failure Developing After Hospital Admission

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Abstract

There are limited data on ADHF that develops after hospital admission. This study sought to compare patient characteristics, comorbidities, mortality, and length of stay by timing of acute decompensated heart failure (ADHF) onset. The surveillance component of the Atherosclerosis Risk in Communities Study (2005–2011) sampled, abstracted, and adjudicated hospitalizations with select ICD-9-CM discharge codes from 4 U.S. communities among those aged 55 years and older. We included 5,602 validated ADHF hospitalizations further classified as pre- or post-admission onset. Vital status was assessed up to 1 year since admission. We estimated multivariable-adjusted associations of in-hospital mortality, 28-day case fatality, and 365-day case fatality with timing of ADHF onset (post-versus pre-admission). All analyses were weighted to account for the stratified sampling design. Of 25,862 weighted ADHF hospitalizations, 7% had post-admission onset of ADHF. Patients with post-admission ADHF were more likely to be older, white, and female. The most common primary discharge diagnosis codes for those with post-admission ADHF included diseases of the circulatory or digestive systems or infectious diseases.

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Disclosures

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Short-term mortality among post-admission ADHF was almost 3 times that of pre-admission ADHF (in-hospital mortality: odds ratio: 2.7, 95% confidence interval: 1.9–3.9; 28-day case fatality: odds ratio: 2.6, 95% confidence interval: 1.8–3.7). The average hospital stay was almost twice as long among post-admission as pre-admission ADHF (9.6 vs. 5.0 days). In conclusion, post-admission onset of ADHF is characterized by differences in comorbidities and worse short-term prognosis, and opportunities for reducing post-admission ADHF occurrence and associated risks need to be studied.

Keywords

acute heart failure; hospitalization; comorbidity; mortality

Introduction

Heart failure (HF) is the most common reason for hospitalization in the US among those 65 years and older, and has a relatively poor prognosis (1). Studies of hospitalized HF focus mainly on patients that present to the hospital with symptoms of acute decompensated HF (ADHF); however, ADHF may develop after admission to the hospital (2, 3). Post-admission onset of ADHF may be iatrogenic such as precipitated by procedures or surgery, intravenous fluid administration, changes in medications, or it may be precipitated by a comorbid medical problem such as myocardial infarction (MI), pulmonary embolus, or atrial fibrillation (4). Although empirical evidence is limited, it is likely that such in-hospital occurrences of ADHF are associated with increased length of hospital stay, morbidity, and mortality (2, 3). Precipitating factors and clinical outcomes are important in informing HF management (5, 6), and additional investigation into the patients characteristics and outcomes associated with post-admission onset of ADHF may improve our understanding of its causes and opportunities for prevention. In this study, we describe the prevalence, patient characteristics and comorbidities, and prognosis associated with post-admission onset of ADHF compared to pre-admission onset in the community surveillance component of the Atherosclerosis Risk in Communities (ARIC) study. This is the first such population-based study of hospitalized ADHF patients in the United States (US).

Methods

Beginning in 2005 and ongoing, the ARIC study samples hospital discharges for HF events occurring in all hospitals serving 4 geographically defined US communities (Forsyth County, North Carolina; Jackson, Mississippi; suburbs of Minneapolis, Minnesota; and Washington County, Maryland). Surveillance procedures for event identification, investigation, and classification have been previously described (7). Briefly, eligible hospital discharges include those among patients 55 years and older residing in 1 of the 4 ARIC communities with a HF-related International Classification of Disease, 9th Revision, Clinical Modification (ICD-9-CM) code in any position (ICD-9-CM code(s) of 398.91, 402.01, 402.11, 402.91, 404.01, 404.03, 404.11, 404.13, 404.91, 404.93, 415.0, 416.9, 425.4, 428.x, 518.4, or 786.0x). Hospitalizations are randomly sampled within strata defined by targeted HF ICD-9-CM codes, age, sex, race, and community of residence. Sampling

probabilities varied by strata and were selected to achieve similar standard errors for HF event rates across strata. Trained personnel abstract medical records for HF symptoms, diagnostic imaging results, levels of cardiac biomarkers, medical history, and other patient characteristics. Abstractors are trained to identify evidence of new or progressive signs and symptoms of heart failure and determine whether signs/symptoms were present at admission or developed after admission. Fully abstracted cases are then classified by physician review or computer algorithm as definite decompensated HF, probable decompensated HF, chronic stable HF, unlikely HF, and unclassifiable. Confirmed HF diagnoses are sent to the National Death Index to obtain vital status information up to 1 year after admission.

From 2005–2011, 5,944 events were identified as definite or probable ADHF from 15,655 eligible discharges sampled for HF ascertainment. In this sample, 50% of hospitalizations were reviewed by a physician, and 64% of final ADHF diagnoses were made by physician review. We excluded patients transferred to or from another hospital (N=116), missing information on timing of decompensation onset (N=89), and race other than black or white (N=137) for a final unweighted sample of 5,602 events. These hospitalizations were further classified as pre- or post-admission onset of ADHF. The primary outcomes of this study included in-hospital mortality, 28-day case fatality, and 365-day case-fatality. At the time of this analysis, events through 2010 had been sent for vital status search. Therefore, events occurring in 2011 were not included in the case fatality analyses. Hospital length of stay (LOS) was defined as the time, in days, from hospital admission to discharge. All covariates were abstracted from the medical record by trained personnel and included patient demographics (age, sex, race), insurance status, current smoking, clinical measures (body mass index and serum creatinine), prior diagnosis or hospitalization for HF, systolic HF (ejection fraction < 50%), medical history (hypertension, diabetes, chronic obstructive pulmonary disease (COPD), MI, coronary artery disease (CAD), atrial fibrillation, valvular heart disease, dialysis), medications (prior to hospitalization or progression of in-hospital HF), and discharge diagnoses (up to 26 listed). Primary discharge diagnoses (in first position) were grouped according to chapters of the ICD-9-CM. Further, for each hospitalization, the entire list of discharge diagnoses was scanned for relevant codes and grouped into comorbid conditions (e.g., atrial fibrillation, chronic kidney disease) and cardiac procedures (i.e., coronary artery bypass graft (CABG) and percutaneous coronary intervention (PCI)) according to the Centers for Medicare and Medicaid Services Chronic Conditions Data Warehouse definitions and Agency for Healthcare Research and Quality's inpatient quality indicators.

Statistical analyses accounted for the stratified sampling design of ARIC HF surveillance and weighted by the inverse of the sampling probability. Rao-Scott chi-square test statistics were used to compute p-values for comparing covariates with timing of ADHF onset (post-admission versus pre-admission) (8). Weighted logistic regression was used to estimate odds ratios with 95% confidence intervals of in-hospital mortality and case fatality with timing of ADHF onset, controlling for potential confounders of age, sex, race, HF type and history, and medical history of smoking, hypertension, diabetes, COPD, MI, CAD, atrial fibrillation, valvular heart disease, and dialysis. Age-adjusted survival curves stratified by ADHF onset were constructed based on a weighted Cox proportional hazards model. Extreme values of hospital LOS were truncated at 300 days (N=5). Due to positive skewness, LOS was log

(base 10) transformed, and geometric means and 95% CI were estimated by timing of ADHF onset. Statistical analyses were conducted using survey procedures in SAS version 9.3 (SAS Institute Inc., Cary, NC).

Results

The weighted sample represented 25,862 ADHF hospitalizations. Of these, 1,902 (7%, 377 unweighted) had post-admission onset of ADHF. The median days from hospital admission to post-admission onset were 2 (interquartile range 1 to 5 days). Patients with post-admission ADHF were more likely to be older and white female (Table 1). Also, among post-admission ADHF patients, a lower proportion had a documented prior diagnosis of HF (57%) compared to pre-admission ADHF (73%). On the other hand, patients with pre-admission ADHF were more likely to have a documented history of smoking, COPD, and valvular heart disease. Use of certain medications prior to hospitalization or progression of HF was mostly similar regardless of the timing of ADHF onset; however, administration of intravenous inotropes was more common in patients with post-admission ADHF.

Both pre- and post-admission ADHF patients had diseases of the circulatory system listed as the leading primary discharge diagnosis (63% and 22%, respectively; Table 2). Diseases of the respiratory system (13%) and infectious diseases (13%) were also common among pre-admission ADHF. As expected, we observed a wider distribution of primary discharge diagnoses among those post-admission ADHF, such as infectious diseases (16%), digestive diseases (15%), and injuries and poisonings (10%). Furthermore, patients with post-admission ADHF were more likely to have an acute MI, renal failure, gastrointestinal hemorrhage, and a cardiac procedure (CABG or PCI) during the hospitalization.

Overall, in-hospital mortality for patients with ADHF was 7%, 28-day case fatality was 12%, and 365-day case fatality was 37%. Patients with post-admission ADHF had substantially worse short-term prognosis; 16% of these patients did not survive to hospital discharge, and 27% died within 28 days (compared to 6% and 11%, respectively, among pre-admission ADHF). Further, 45% of post-admission ADHF were deceased by 1-year since admission (compared to 37% among pre-admission ADHF). After adjusting for potential confounders, we observed strong relative differences between post- and pre-admission ADHF in in-hospital mortality and 28-day case fatality (Table 3). The association of 365-day case fatality with post-admission onset was much weaker, though still statistically significant. The age-adjusted survival curves show a sharp, early divergence between pre- and post-admission onset of ADHF while no further divergence after 2 to 3 months since admission (Figure 1).

Hospital LOS was, on average, 5.2 days in all ADHF patients (Table 4). It was an average 4.6 days longer for patients with post-admission ADHF. This difference remained regardless of patient's vital status at discharge. Moreover, the mean time from ADHF onset during the hospitalization to discharge among post-admission ADHF patients (6.0 days) still exceeded the mean entire LOS of pre-admission onset ADHF patients (5.0 days).

Discussion

This study of 5,602 (25,862 weighted) ADHF hospitalizations compared patient characteristics and outcomes by the timing of ADHF onset using population-based surveillance in 4 U.S. communities. We found the development of acute decompensation during the hospital stay occurred in a small proportion, 7%, of all hospitalized ADHF. However, of importance, patients with post-admission onset of ADHF were more likely to have poor short-term prognosis and longer hospital stay compared to those with pre-admission onset. Also, these patients were less likely to have a prior diagnosis or hospitalization for HF, suggesting in-hospital ADHF is more likely a de novo presentation of HF.

While the primary diagnosis for pre-admission ADHF was predominantly of a circulatory or respiratory nature, patients with post-admission ADHF were hospitalized for a wider range of reasons, including diseases of the circulatory and digestive systems and infections. Further, our findings suggest comorbid conditions like acute MI, renal failure, gastrointestinal hemorrhage, and a medical procedure (any or coronary intervention, specifically) may be important precipitating factors of in-hospital onset of ADHF. Presumably, these comorbidities are related to the administration of intravenous fluids or blood products for procedures and transfusions and to low ejection fraction or arrhythmia.

The frequency of post-admission ADHF onset in our study (7%) is somewhat consistent with a previous study by Taylor, et al. (13%) of 359 consecutively admitted ADHF patients from a single hospital (3). Moreover, both studies observed a large proportion of these patients also presented with MI and arrhythmias. However, our study found a higher prevalence of renal failure (27%) than Taylor, et al. found (6%) in a small sample (N=47) from a single hospital in Australia (3). Notably, they collected data specifically on precipitants of ADHF, such as respiratory infection and intravenous fluid complications (3). In our study, data were not collected or available on precise causes of ADHF onset during the hospital stay. Therefore, estimates may not be comparable. Furthermore, we were not able to determine the number of potentially avoidable ADHF cases from iatrogenic causes, such as improper medication dosage or intravenous fluid administration.

Our findings show post-admission ADHF has a poorer prognosis, especially in the short term, with the risks of in-hospital mortality and 28-day case fatality almost 3 times that of pre-admission ADHF. Two previous studies also reported in-hospital onset or iatrogenic HF as having roughly 3 times the in-hospital mortality as onset prior to hospitalization or non-iatrogenic cases (2, 3). In our study, adjusted 365-day case fatality only modestly differed by timing of ADHF onset. Rich, et al. reported a significantly higher 1-year mortality in iatrogenic HF cases and also noted survival curves comparing iatrogenic (N=28) and non-iatrogenic (N=373) patients no longer diverged after 3 months post-discharge (2). Although we did not specifically study iatrogenic cases, we also observed similar differences in survival curves (Figure 1). Our study further adds to the evidence of greater short-term mortality among in-hospital onset of ADHF. In a secondary analysis exploring the role of acute MI in the post-admission onset of ADHF, we found similar estimates of in-hospital mortality and 28-day case fatality, in addition to 365-day case fatality, between patients with

or without acute MI at the time of ADHF hospitalization. Nonetheless, our study shows the patient subgroup with onset of ADHF after admission has a 40% risk of death within 1 year, suggesting in-hospital onset is a harbinger of short- or long-term generalized failure.

Length of hospital stay is commonly used as a surrogate measure for the cost of acute cardiovascular care (9). A large observational study of Medicare patients with HF recently reported a mean LOS of 6.3 days (10), which is closer to the average LOS for pre-admission ADHF than that for post-admission ADHF found in our study. This suggests the latter subgroup requires more health care as a result of the onset of ADHF as a complication, and may also explain the increased risk of in-hospital death. However, regardless of patient vital status at discharge, we observed a significantly longer average LOS for ADHF developing after admission. Moreover, time from ADHF onset to discharge, on average, exceeded the entire LOS of pre-admission ADHF.

Multi-site HF registries in the U.S. have been used to predict in-hospital mortality with the aim of creating risk-stratification or -prediction models to inform clinical management of HF (11–13). These studies observed 3–4% in-hospital mortality, which is far lower than the 17% inhospital mortality we found among post-admission ADHF patients. While the focus of these studies was on patients presenting with acute HF at hospital admission, our findings suggest the patient subgroup with ADHF occurring during the hospital stay is important to recognize in clinical practice, given its worse short-term prognosis, differences in characteristics and comorbidities, and opportunities to reduce risk while under medical management.

To our knowledge, this is the first population-based study in the U.S. to compare pre- and post-admission acute decompensation in validated HF hospitalizations. The ARIC study samples hospitalizations from 4 U.S. communities with standardized methods. Weighted analyses account for this sampling strategy and allow inference to these communities. Our results, however, may not generalize to the entire U.S. population. Because hospitalizations are sampled, direct linkage of individual patients to hospitalizations is not possible, limiting our ability to study the occurrence of rehospitalizations. Lastly, the cause of in-hospital ADHF onset is not systematically captured in these data. Despite these limitations, this is the largest, systematic study to date of a validated sample of ADHF hospitalizations.

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Figure 1.

One-year survival curves comparing pre-admission and post-admission onset of acute decompensated heart failure, the ARIC Community Surveillance Study, 2005–2010 (N=19,475). Case fatality information obtained for events through 2010. Lines show the estimated survival probability by number of days since hospital admission from an age-adjusted, weighted Cox proportional hazards model. Solid line represents pre-admission onset of ADHF while dashed line represents post-admission onset of ADHF.

Abbreviations: ADHF=acute decompensated heart failure

Table 1

Patient characteristics of acute decompensated heart failure hospitalizations by timing of onset, the ARIC Community Surveillance Study, 2005–2011 (N=25,862)

Variable	Pre-Admission ADHF (N ^a =23,959)	Post-Admission ADHF (N ^a =1,902)	p-value
Age 55–69 (years)	7,415 (31%)	392 (21%)	<.0001
70–79	6,774 (28%)	496 (26%)	
80+	9,770 (41%)	1,015 (53%)	
Black Female	3,805 (16%)	265 (14%)	<.0001
Black Male	3,511 (15%)	117 (6%)	
White Female	8,675 (36%)	847 (45%)	
White Male	7,968 (33%)	673 (35%)	
Private insurance or Medicare	21,177 (89%)	1,718 (92%)	0.10
Systolic HF (ejection fraction < 50%)	12,200 (56%)	918 (55%)	0.63
Body mass index ^b (kg/m ² , mean [SE])	29.3 (0.1)	28.4 (0.5)	<.0001
Serum creatinine (mg/dL, mean [SE])	2.1 (0.03)	2.2 (0.08)	0.70
Prior diagnosis of HF	17,518 (73%)	1,082 (57%)	<.0001
Prior hospitalization for HF	9,071 (38%)	391 (21%)	<.0001
Current smoker	3,360 (14%)	141 (7%)	0.001
Hypertension	20,328 (85%)	1,643 (86%)	0.52
Diabetes mellitus	11,484 (48%)	857 (45%)	0.35
Chronic obstructive pulmonary disease	8,655 (36%)	423 (22%)	<.0001
Myocardial infarction	6,514 (27%)	548 (29%)	0.57
Coronary artery disease	11,142 (47%)	853 (45%)	0.58
Atrial fibrillation	8,947 (37%)	660 (35%)	0.38
Valvular heart disease	6,194 (26%)	391 (21%)	0.04
Dialysis	1,692 (7%)	96 (5%)	0.16
Medications prior to hospitalization or progression of HF			
Angiotensin-converting enzyme inhibitor or angiotensin receptor blocker	12,001 (50%)	836 (44%)	0.04
Beta blockers	15,948 (67%)	1,243 (65%)	0.67
Diuretics, oral or intravenous	21,925 (92%)	1,764 (93%)	0.45
Intravenous diuretics	19,336 (81%)	1,561 (82%)	0.56
Intravenous inotropes	1,468 (6%)	203 (11%)	0.001

Abbreviations: ADHF=acute decompensated heart failure; SE=standard error;

^a N is weighted as discussed in the methods section

^b Extreme values of body mass index (<15.7 (1st percentile) or >58.9 (99th percentile) kg/m²) coded to missing (overall 18% missing)

Table 2

Primary diagnoses and comorbid conditions for acute decompensated heart failure hospitalizations according to timing of onset, the ARIC Community Surveillance Study, 2005–2011 (N=25,449)

Primary Discharge Diagnosis Grouped by ICD-9-CM Chapter	Pre-Admission ADHF (N ^a =23,582)	Post-Admission ADHF (N ^a =1,866)	p-value
Infectious and parasitic diseases (001–139)	2,973 (13%)	301 (16%)	<.0001 ^b
Neoplasms (140–239)	193 (1%)	88 (5%)	
Endocrine, nutritional and metabolic diseases, and immunity disorders (240–279)	347 (1%)	96 (5%)	
Diseases of the blood and blood-forming organs (280–289)	77 (0%)	16 (1%)	
Mental disorders (290–319)	46 (0%)	2 (0%)	
Diseases of the nervous system and sense organs (320–389)	39 (0%)	16 (1%)	
Diseases of the circulatory system (390–459)	14,755 (63%)	415 (22%)	
Diseases of the respiratory system (460–519)	3,069 (13%)	120 (6%)	
Diseases of the digestive system (520–579)	415 (2%)	277 (15%)	
Diseases of the genitourinary system (580–629)	718 (3%)	123 (7%)	
Diseases of the skin and subcutaneous tissue (680–709)	75 (0%)	51 (3%)	
Diseases of the musculoskeletal system and connective tissue (710–739)	73 (0%)	124 (7%)	
Symptoms, signs, and ill-defined conditions (780–799)	435 (2%)	34 (2%)	
Injury and poisoning (800–999)	324 (1%)	179 (10%)	
Supplementary classification of factors influencing health status and contact with health services (V01–V89)	12 (0%)	10 (1%)	
Supplementary classification of external cause of injury and poisoning (E800–E999)	4 (0%)	---	
Procedures (00–99)	28 (0%)	14 (1%)	
Comorbid Conditions and Procedures ^c (ICD-9-CM code(s))			
Ischemic heart disease	12,867 (54%)	1,064 (56%)	0.55
Acute myocardial infarction (410.x)	2,080 (9%)	1,501 (21%)	<.0001
Atrial fibrillation (427.31)	9,566 (40%)	808 (42%)	0.39
Chronic kidney disease	8,815 (37%)	792 (42%)	0.10
Renal failure (584.x or 586.x)	3,242 (14%)	506 (27%)	<.0001
Chronic obstructive pulmonary disease and bronchiectasis	5,385 (22%)	293 (15%)	0.008
Pneumonia	3,097 (13%)	244 (13%)	0.96
Gastrointestinal hemorrhage	466 (2%)	123 (6%)	<.0001
Hip or pelvic fracture	51 (0%)	29 (2%)	<.0001
Any procedure	6,456 (27%)	957 (50%)	<.0001
Operation on cardiovascular system (35.x – 39.x)	4,958 (21%)	652 (34%)	<.0001
Coronary artery bypass graft or percutaneous coronary intervention	536 (2%)	105 (6%)	0.005

Abbreviations: ADHF=acute decompensated heart failure; ICD-9-CM=International Classification of Disease, 9th Revision, Clinical Modification

^aN is weighted as discussed in the methods section

^b Calculated by grouping ICD-9-CM chapters on diseases of the blood and blood-forming organs; mental disorders; diseases of the nervous system and sense organs; diseases of the skin and subcutaneous tissue; symptoms, signs, and ill-defined conditions; supplementary classification of factors influencing health status and contact with health services; supplementary classification of external cause of injury and poisoning; and procedures to eliminate zero and low frequencies.

^c Presence of discharge diagnosis or procedure ICD-9-CM code in any position; diagnosis codes based on Centers for Medicare and Medicaid Services chronic condition warehouse categories; pneumonia, gastrointestinal hemorrhage, and cardiac procedure codes based on Agency for Healthcare Research and Quality inpatient quality indicators

Table 3

Comparison of mortality among patients with post-admission versus pre-admission onset of acute decompensated heart failure decompensation, the ARIC Community Surveillance Study, 2005–2011 (N=25,862)

	Adjusted Odds Ratios (95% Confidence Intervals) ^a		
	In-Hospital Mortality	28-Day Case Fatality ^b	365-Day Case Fatality ^b
Post-admission ADHF (versus pre-admission ADHF)	2.7 (1.9, 3.9)	2.6 (1.8, 3.7)	1.5 (1.1, 2.0)
Age group			
55–69 years	0.4 (0.3, 0.6)	0.4 (0.3, 0.5)	0.5 (0.4, 0.6)
70–79 years	0.7 (0.5, 0.9)	0.6 (0.5, 0.8)	0.6 (0.5, 0.8)
80+ years (referent)			
Race-sex group			
Black Female	0.8 (0.5, 1.2)	0.8 (0.6, 1.2)	1.2 (0.9, 1.5)
Black Male	0.8 (0.6, 1.2)	1.0 (0.7, 1.5)	1.1 (0.9, 1.4)
White Female	1.0 (0.7, 1.4)	1.0 (0.7, 1.4)	1.1 (0.9, 1.4)
White Male (referent)			
Systolic HF (ejection fraction < 50%)	1.4 (1.1, 1.8)	1.3 (1.0, 1.7)	1.2 (1.0, 1.4)
Prior diagnosis of HF	0.8 (0.6, 1.1)	0.9 (0.7, 1.2)	1.5 (1.3, 1.8)
Medical history			
Current smoking	1.0 (0.7, 1.5)	1.1 (0.7, 1.6)	0.8 (0.7, 1.1)
Hypertension	1.0 (0.7, 1.4)	1.0 (0.7, 1.4)	0.9 (0.7, 1.1)
Diabetes mellitus	1.0 (0.7, 1.2)	0.9 (0.7, 1.2)	1.0 (0.8, 1.1)
Chronic obstructive pulmonary disease	1.3 (1.0, 1.7)	1.1 (0.9, 1.5)	1.4 (1.1, 1.6)
Myocardial infarction	1.0 (0.7, 1.3)	1.0 (0.8, 1.4)	1.1 (0.9, 1.3)
Coronary artery disease	0.9 (0.7, 1.2)	1.1 (0.9, 1.5)	1.0 (0.8, 1.2)
Atrial fibrillation	1.2 (0.9, 1.6)	1.2 (0.9, 1.5)	1.0 (0.8, 1.2)
Valvular heart disease	1.1 (0.8, 1.4)	1.0 (0.8, 1.4)	1.2 (1.0, 1.4)
Dialysis	1.4 (0.9, 2.2)	1.2 (0.8, 1.8)	1.3 (1.0, 1.8)

Abbreviation: ADHF=acute decompensated heart failure

^aLogistic models included variables for post-admission ADHF, age group, race-sex group, systolic HF type, prior diagnosis of HF, and history of smoking, hypertension, diabetes, chronic obstructive pulmonary disease, myocardial infarction, coronary artery disease, atrial fibrillation, valvular heart disease, and dialysis

^bCase fatality information obtained for events through 2010 (N=19,475)

Average length of hospital stay (in days), overall and by timing of acute decompensated heart failure and vital status at discharge, the ARIC Community Surveillance Study, 2005–2011 (N=25,764)

Table 4

	All		Vital Status at Discharge					
			Alive			Deceased		
	N ^a	GM (95% CI)	N ^a	GM (95% CI)	N ^a	GM (95% CI)	N ^a	GM (95% CI)
All ADHF	25,764	5.2 (5.1, 5.4)	23,925	5.2 (5.0, 5.3)	1,840	6.6 (5.9, 7.4)		
Pre-admission onset	23,876	5.0 (4.9, 5.1)	22,342	4.9 (4.8, 5.1)	1,533	6.0 (5.4, 6.8)		
Post-admission onset	1,889	9.6 (8.8, 10.5)	1,582	9.4 (8.5, 10.4)	306	10.6 (8.3, 13.6)		

Abbreviations: ADHF=acute decompensated heart failure; CI=confidence interval; GM=geometric mean

^aN is weighted as discussed in the methods section