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Quality of Care for Heart Failure Patients Hospitalized for Any Cause

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Abstract

Objectives—The study sought to assess the quality of care for heart failure patients who are hospitalized for all causes.

Background—Performance measures for heart failure target patients with a principal diagnosis of heart failure. However, patients with heart failure are commonly hospitalized for other causes and may benefit from treatments such as angiotensin-converting enzyme (ACE) inhibitors for left ventricular (LV) systolic dysfunction.

Methods—We assessed rates of compliance with care measures for patients hospitalized with acute or chronic heart failure in the ARIC (Atherosclerosis Risk in Communities) study surveillance catchment area from 2005 to 2009. Rates of compliance were compared between patients with a principal discharge diagnosis of heart failure and those with another principal discharge diagnosis.

Results—Of 4,345 hospitalizations of heart failure patients, 39.6% carried a principal diagnosis of heart failure. Patients with a principal heart failure diagnosis had higher rates of LV function assessment (89.1% vs. 82.5%; adjusted prevalence ratio [aPR]: 1.07; 95% confidence interval [CI]: 1.04 to 1.10) and discharge ACE inhibitor/angiotensin receptor blocker (ARB) in LV dysfunction (64.1% vs. 56.3%; aPR: 1.11; 95% CI: 1.03 to 1.20) as compared to patients hospitalized for another cause. LV assessment and ACE inhibitor/ARB use were associated with reductions in 1-year post-discharge mortality (adjusted odds ratio: 0.66, 95% CI: 0.51 to 0.85; adjusted odds ratio: 0.72, 95% CI: 0.54 to 0.96, respectively) that did not differ for patients with versus without a principal heart failure diagnosis.

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APPENDIX

For a supplementary table, please see the online version of this article.

Conclusions—Compared with individuals hospitalized with a principal diagnosis of heart failure, heart failure patients hospitalized for other causes were less likely to receive guideline recommended care. Quality initiatives may improve care by targeting hospitalizations with either principal or secondary heart failure diagnoses.

Keywords

heart failure; hospitalization; quality of care

Individuals with heart failure experience high rates of hospitalization and death (1). Given the significant morbidity and mortality associated with heart failure, a substantial effort has been placed on ensuring that heart failure patients receive guideline-endorsed care that is associated with improved outcomes. To encourage quality care, the Centers for Medicare and Medicaid Services (CMS) have developed performance measures for hospitalized patients. These measures currently include evaluation of left ventricular (LV) systolic function, prescription of an angiotensin-converting enzyme (ACE) inhibitor or angiotensin receptor blocker (ARB) for individuals with LV systolic dysfunction at time of discharge, and discharge instructions (2). The American College of Cardiology Foundation, American Heart Association, and American Medical Association–Physician Consortium for Performance Improvement (ACCF/AHA/AMA-PCPI) have endorsed similar quality measures for adults with heart failure (3).

Both the CMS and ACCF/AHA/AMA-PCPI performance measures specifically target patients whose primary reason for admission is heart failure, based on the principal discharge diagnosis code (2,3). Thus, these measures do not apply to patients with heart failure with another principal discharge diagnosis. Similarly, current registries of heart failure hospitalizations, which were created to evaluate and improve inpatient care, focus on patients who are hospitalized with acute heart failure (4–6). Nonetheless, the majority of hospitalizations of heart failure patients are for reasons other than heart failure (7–9). While care measures for heart failure are reported only for those patients with a principal diagnosis of heart failure, some measures are beneficial to all patients with heart failure, including LV function assessment and ACE inhibitor or ARB use in LV systolic dysfunction (3,10).

The purpose of this study is to determine the quality of care for individuals hospitalized with a principal diagnosis of heart failure and individuals with heart failure who are admitted with a principal diagnosis other than heart failure. As quality improvement initiatives for heart failure have not been routinely targeting heart failure patients hospitalized for other reasons, we hypothesized that patients with heart failure admitted for other causes would receive less optimal care for heart failure as compared to individuals who are specifically hospitalized for heart failure. We further hypothesized that quality measures would be associated with improved outcomes in heart failure, regardless of the reason for hospitalization.

Methods

The ARIC (Atherosclerosis Risk in Communities) study is a prospective study of cardiovascular disease among individuals from 4 U.S. communities (11). To study the prevalence of heart failure hospitalizations, the ARIC study began surveillance of hospital discharge records for all residents of the 4 communities in 2005. Inclusion criteria for hospitalization review included age >55 years, home address within 1 of the 4 communities, and an International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) discharge diagnosis code for heart failure or a related condition or symptom (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, 786.0x). Discharge diagnosis codes could be in any position for inclusion (12,13).

Eligible hospitalizations were identified through review of medical records from hospitals serving the ARIC communities. Stratified random sampling was used to identify hospitalizations for initial abstraction by trained abstractors (12). Detailed chart abstraction was performed if there was evidence of symptoms that could be related to heart failure or physician documentation of heart failure as the reason for hospitalization. Hospitalizations with detailed chart abstractions were subsequently adjudicated by a committee of physicians. The committee classified hospitalizations into the following categories: acute decompensated heart failure, chronic stable heart failure, heart failure unlikely, or unclassifiable (12,13). As previously described (13), classification of acute decompensated heart failure was favored if there was evidence of worsening heart failure symptoms with augmentation of therapy, while chronic stable heart failure was selected if there was evidence of heart failure without change in symptoms.

The population for the present study was selected as a cohort of individuals with adjudicated heart failure, either acute decompensated heart failure or chronic stable heart failure, from 2005 to 2009. We excluded individuals who were transferred to another hospital or who died during hospitalization.

We compared the rate of compliance with quality of care measures for individuals with heart failure who were hospitalized with a principal diagnosis of heart failure and those hospitalized for another cause. Principal heart failure diagnosis was based on ICD-9-CM codes used by CMS and ACCF/AHA/AMA-PCPI listed in the primary position (2,3). Additionally, we repeated the analyses using 3 alternative definitions of heart failure as cause of hospitalization. The first was determined by the response to the following question by trained abstractors: was there evidence from physician notes that heart failure was the primary reason for hospitalization. This definition may best reflect the physician perception of the reason for admission and should not be influenced by hospital coders. The second alternate definition was the ARIC study adjudicated diagnosis of acute versus chronic heart failure. The third alternate definition used a combination of the ARIC study definition and ICD-9-CM coding. Similar to that used in some quality initiatives (5), this definition included hospitalizations with a principal heart failure diagnosis that was also adjudicated as acute heart failure.

The primary outcomes were the 2 CMS inpatient heart failure quality measures available in the ARIC study dataset: assessment of LV function and discharge prescription of an ACE inhibitor or ARB for individuals with LV systolic dysfunction. LV function assessment was determined based on chart evidence of assessment either prior to or during the hospitalization.

Rates of compliance for 3 additional discharge measures were evaluated: prescription of a beta-blocker for individuals with LV systolic dysfunction, prescription of an aldosterone antagonist for individuals with LV systolic dysfunction and creatinine ≤2.5 mg/dl in men and ≤2.0 mg/dl in women, and prescription of anticoagulation for individuals with atrial fibrillation. These guideline recommended therapies (10) are not nationally reported measures but have been considered as emerging measures of care in heart failure (14). In the ARIC study, information regarding anticoagulation at discharge was only available for a random 20% sample of hospitalizations that had supplemental data abstracted. For comparison, we also evaluated the rate of statin use among patients with a history of coronary heart disease; we were unable to assess aspirin utilization as information on this medication was frequently missing.

Demographic characteristics, medical history, and clinical results were obtained through medical record abstraction. LV systolic dysfunction was considered present if either the physician reviewer indicated abnormal systolic function or the documented ejection fraction was <50%. Edema, systolic blood pressure, and weight were obtained at time of admission; we used spline terms for blood pressure up to and above 140 mm Hg (15). Discharge sodium and estimated glomerular filtration rate (eGFR) were based on the final sodium and creatinine laboratory values during hospital admissions, respectively; eGFR was based on the CKD-EPI (Chronic Kidney Disease Epidemiology Collaboration) equation (16) and categorized.

Mortality data were obtained from the National Death Index and determined for 1 year following discharge. Mortality data were only available for individuals discharged during the period of 2005 to 2008.

Statistical analysis

Baseline characteristics were compared between groups using chi-square and *t* tests. Poisson regression (17) was used to estimate the prevalence ratio of compliance with quality measures for individuals with as compared to those without a principal heart failure diagnosis, after adjustment for a priori selected covariates of age, gender, race, insurance, systolic blood pressure, eGFR, and history of coronary heart disease, diabetes, asthma, chronic obstructive pulmonary disease (COPD), dialysis, stroke, and atrial fibrillation.

Logistic regression was used to determine the associations of a primary discharge diagnosis of heart failure and adherence to quality measures with mortality following discharge. Covariates in the models were those available in the ARIC study dataset that were similar to predictors of mortality in a prior study of hospitalized patients with heart failure and included age, systolic blood pressure, eGFR, sodium, presence of edema, statin at discharge, and history of coronary heart disease, diabetes, asthma, COPD, stroke, and depression (15) plus the additional demographic covariates of race, gender, and insurance. We developed a primary model and then a second model with an interaction term of the quality measure and an index of whether heart failure was the principal discharge diagnosis. Logistic regression models were also developed for both individuals with a principal diagnosis of heart failure and those with another principal diagnosis.

Several sensitivity analyses were performed. First, we determined the association between each of the 3 alternative definitions of heart failure. Second, we repeated our primary analysis with limiting inclusion to CMS heart failure diagnosis in the primary or secondary position. This analysis was done as hospitalizations screened and potentially adjudicated in the ARIC study as heart failure included codes outside of the CMS coding definition of heart failure, including such diagnoses as rheumatic heart failure, cor pulmonale, and shortness of breath. Third, we estimated the adjusted prevalence ratio of the measures for individuals with as compared to those without a principal heart failure diagnosis by eGFR categories and COPD status.

All statistical analyses accounted for the sampling design of the ARIC surveillance study. Statistical significance was pre-specified at an alpha level of 0.05 (2-tailed). Analyses were performed using Stata 12 (StataCorp, College Station, Texas).

Results

There were 4,345 hospitalizations that were sampled and adjudicated as acute decompensated or chronic heart failure and included in the study. Of these, 1,723 (39.7%) hospitalizations carried a principal diagnosis of heart failure. Hospitalizations with a

principal diagnosis of heart failure were more likely to have been adjudicated as acute decompensated heart failure as compared with those with another principal diagnosis (97.4% vs. 70.9%, $p < 0.001$). Black race was more commonly observed among heart failure patients hospitalized with a principal diagnosis of heart failure (Table 1). Individuals with a principal diagnosis other than heart failure had a higher prevalence of a number of non-cardiovascular comorbid conditions, including COPD and depression (Table 1).

Of all acute or chronic heart failure hospitalizations, 85.1% had a record of LV function assessment. Individuals with a principal diagnosis of heart failure were more likely to have received assessment of LV function as compared to individuals with another principal diagnosis (Table 2). Among individuals with LV systolic dysfunction, 59.7% were prescribed an ACE inhibitor or ARB at discharge; individuals with a principal diagnosis of heart failure had a 14% higher rate of prescription for an ACE inhibitor or ARB at discharge, with similar results after adjustment for important covariates (Table 2). As compared with individual with another principal diagnosis, individuals with a principal diagnosis of heart failure had a similar rate of prescription for β-blockers and anticoagulants at time of discharge, when appropriate. Both groups had low rates of aldosterone antagonist utilization for individuals with LV systolic dysfunction and creatinine levels below the recommended threshold, with 17.1% overall compliance with this measure. Nonetheless, individuals admitted with a principal diagnosis of heart failure were more likely to have received aldosterone antagonists at discharge (Table 2). Among patients with coronary heart disease, 46% were prescribed a statin at time of discharge.

Mortality follow-up was available for the 3,201 individuals discharged between 2005 and 2008. Among these individuals, the 1-year mortality rate was 26.0% and was similar for individuals with and without a principal diagnosis of heart failure (25.6 vs. 26.2; $p = 0.76$). After adjusting for covariates, the presence of a principal diagnosis of heart failure was associated with an odds ratio for mortality of 0.92 (95% confidence interval [CI]: 0.76 to 1.13) as compared with a principal diagnosis other than heart failure.

Individuals hospitalized with heart failure with assessment of LV systolic function had an adjusted odds ratio (OR) for mortality following discharge of 0.66 (95% CI: 0.51 to 0.85) as compared with individuals who did not have LV assessment. There was no difference in the relationship of LV assessment and mortality for individuals with versus without a principal diagnosis of heart failure (p interaction = 0.79) (Table 3). Prescription of an ACE inhibitor or ARB at discharge was associated with improved survival for individuals with LV systolic dysfunction (adjusted OR for mortality: 0.72; 95% CI: 0.54 to 0.96). The association between ACE inhibitor/ARB use at discharge and subsequent mortality was similar for individuals with and without a principal diagnosis of heart failure (p interaction = 0.66) (Table 3).

There was no difference between the 2 groups in the association between 2 of the emerging process measures and mortality. Beta-blocker use was associated with improved post-discharge were mortality for individuals with LV systolic dysfunction who hospitalized both with and without a principal diagnosis of heart failure (p interaction = 0.83). Use of aldosterone antagonist for individuals with LV dysfunction was associated with a reduction in post-discharge mortality that did not reach statistical significance (adjusted OR: 0.69; 95% CI: 0.47 to 1.01) and was similar between groups (p interaction = 0.41). Conversely, the associated benefit of anticoagulation for atrial fibrillation differed between groups (p interaction = 0.04). Anticoagulation for atrial fibrillation was associated with improved mortality among individuals hospitalized with a principal diagnosis other than heart failure; this association was not observed among individuals hospitalized with a principal heart failure diagnosis (Table 3).

Sensitivity analyses

Results of the primary analyses were similar when using the 3 alternative definitions of heart failure as the responsible diagnosis for admission. Individuals for whom the physician documented heart failure as the reason for hospitalization had higher rates of LV assessment (87.7% vs. 79.2%; $p < 0.0001$) and ACE inhibitor or ARB at discharge for LV systolic dysfunction (62.3% vs. 52.9%; $p < 0.001$) as compared with individuals with heart failure for whom the physician did not document heart failure as the reason for hospitalization. The differences between these 2 groups persisted after multivariate adjustment (Table 4). As compared with individuals hospitalized with ARIC study adjudicated chronic heart failure, individuals hospitalized with adjudicated acute heart failure had a higher rate of LV assessment (87.4% vs. 75.0%; $p < 0.0001$) and a nonsignificant increase in ACE inhibitor or ARB utilization (60.5% vs. 55.7%; $p = 0.13$) (Table 4). Individuals hospitalized with adjudicated acute heart failure and a principal discharge diagnosis of heart failure also had higher rates of LV assessment (89.2 vs. 82.5%; $p < 0.0001$) and ACE inhibitor or ARB at discharge for LV systolic dysfunction (64.2% vs. 56.3%; $p < 0.01$) as compared with individuals with adjudicated chronic heart failure or a principal diagnosis other than heart failure. When we considered only hospitalizations with a heart failure diagnosis defined by the CMS definition, a total of 3,810 individuals were included in the analyses. The results for these individuals were nearly identical to the primary analysis (data not shown). Among subgroups of eGFR categories and individuals with COPD, the adjusted prevalence ratios of the measures of LV assessment, prescription of an ACE inhibitor or ARB, and prescription of a β-blocker for individuals with versus without a principal diagnosis of heart failure were similar to the results of the overall cohort (Online Table).

Discussion

Substantial efforts have been made to measure and improve the quality of care delivered to heart failure patients in both the inpatient and outpatient setting (2–6,18). Inpatient quality of care has focused primarily on patients with a diagnosis of acute heart failure, commonly identified by principal discharge diagnosis code (2–6). Our results suggest that quality improvement initiatives have had an effect on care delivery in a representative sample of 4 communities: we found that 2 commonly used measures of heart failure care, assessment of LV systolic function and prescription of an ACE inhibitor or ARB at time of discharge for patients with LV systolic dysfunction, were more likely to be achieved in patients with a principal diagnosis of heart failure as compared to those with another principal diagnosis. Conversely, β-blocker therapy for LV systolic dysfunction did not differ between groups. Of note, β-blocker therapy is not a CMS quality measure and became an ACCF/AHA/AMA-PCPI performance measure for patients with a principal diagnosis of heart failure only as of 2012 (2,3), so there might not have been incentives to target this therapy specifically to patients with a principal diagnosis of heart failure during the study period.

We found that the majority of hospitalizations for individuals with heart failure had a principal diagnosis that was not heart failure, a finding consistent with previous studies (7–9). Although hospitalizations with a principal diagnosis other than heart failure generally are not subject to heart failure quality improvement measures, the metrics we evaluated are consistent with guideline-recommended care for all heart failure patients (10). Thus, these measures should have clinical value for heart failure patients hospitalized for other causes. We found that, as compared with individuals with a principal diagnosis of heart failure, heart failure patients hospitalized with a non–heart failure diagnosis had a 7% lower rates of LV functional assessment, a 10% lower rate of prescription for an ACE inhibitor or ARB at time of discharge, and lower rates of prescription for an aldosterone antagonist. These data suggest that heart failure patients admitted for other diagnoses may be receiving lower rates of guideline-concordant care as compared to patients whose primary reason for

hospitalization is acute heart failure. These findings are notable as we found selected measures to have associations with mortality that provided comparable benefit for individuals both with and without a principal heart failure diagnosis in a real-world setting. These results suggest that improving compliance with processes of care such as LV assessment and, as appropriate, discharge prescriptions for ACE inhibitors/ARBs, beta-blockers, aldosterone antagonists, and anticoagulants, may result in improved survival among both individuals with a primary diagnosis of heart failure as well as those with a secondary diagnosis of heart failure. The potential for improved outcomes with quality care for individuals with a secondary heart failure diagnosis is particularly important, as these individuals are more commonly seen in the hospital and are less likely to receive heart failure-related therapies than individuals with a principal heart failure diagnosis.

The ACCF/AHA/AMA-PCPI recently updated their recommendations for performance measures for heart failure (3) A number of the measures, including LV systolic assessment and ACE inhibitors or ARBs and β-blockers for LV systolic dysfunction, applied to both the inpatient and outpatient clinical encounters. In these recommendations, while outpatient measures are applicable to all patients with a diagnosis of heart failure, inpatient measures are specific to those patients for whom heart failure is the primary cause for hospitalization. In this paradigm, a hospitalization in which heart failure is either a secondary reason for hospitalization or a stable, chronic condition may be similarly subject to heart failure quality measures as an outpatient encounter.

Our data suggest that there may be a missed opportunity to deliver these quality metrics to heart failure patients whose primary reason for hospitalization is a different cause. Our study included only individuals with adjudicated acute or chronic heart failure, both of whom are appropriate for guideline concordant care such as ACE inhibitors for LV systolic dysfunction. One potential limitation of expanding performance measurement to heart failure patients who are hospitalized for any cause is a loss of specificity for heart failure. Indeed, a prior study from the ARIC study demonstrated that the ICD-9 code of 428 in any position carried a 23% false positive rate for acute or chronic heart failure as compared with only 3% for this code as the principal diagnosis (13). However, the imperfect specificity may represent an opportunity for coding improvement, particularly as increased coding for heart failure may be inappropriately driven by reimbursement incentives (19). More so, expanding quality measures to individuals with a heart failure diagnosis in any position will significantly increase the sensitivity for detection of heart failure; in the ARIC study, the sensitivity was 0.95 for ICD-9 code 428 in any position versus 0.36 in the primary position (13).

We observed that adherence to care measures such as LV evaluation and ACE inhibitors or ARBs for LV dysfunction was associated with reduced mortality among patients with heart failure. Prior studies have questioned whether inpatient care measures have direct clinical benefits. For instance, in a large registry of heart failure hospitalizations, performance measures were generally found to have no association with outcomes (20) and other studies have been inconclusive (21,22). Nonetheless, care measures have been associated with improved outcomes in the outpatient setting (23). Further evaluation of the effect of current heart failure care measures on mortality and rehospitalization is needed.

Study limitations

Our findings must be interpreted with several caveats. First, the analysis was limited by the inability to assess physician exceptions for not adhering with measures. For instance, we were unable to determine if echocardiography was previously performed but not recorded in the chart or was planned for post-discharge and we could not detect if an ACE inhibitor was not prescribed because an individual had an allergy to this medication or had acute kidney

injury. We partly addressed this issue through our sensitivity analyses and found that adherence to performance measures was similar for individuals with different levels of kidney disease and those with COPD. Second, residual measured and unmeasured confounding may account for some of the findings in this observational study. Third, due to limitations in the data, we were unable to assess the relationship of the selected performance measures with clinically important outcomes such as rehospitalizations, quality of life, and costs. Fourth, due to the design of the ARIC study, hospitalizations were fully abstracted only if there was evidence of worsening symptoms of heart failure. Therefore, hospitalizations adjudicated as chronic stable heart failure represented only a subsample of chronic stable heart failure hospitalizations in the ARIC study communities. The reduced number of chronic heart failure hospitalizations included in the study partly accounts for the finding of a high rate (70.9%) of acute decompensated heart failure among hospitalizations with a principal diagnosis other than heart failure. Nonetheless, this finding can be explained by the fact that heart failure decompensation is commonly precipitated by another condition that may result in hospitalization (10); in this context, a patient who is principally hospitalized for pneumonia or renal failure will also have concurrent acute heart failure. Fifth, we defined LV systolic dysfunction as an ejection fraction of <50%, based on the ARIC study abstraction definition. While this cutoff is commonly used in research (8,24), performance measures typically define LV systolic dysfunction as an ejection fraction of <40% (2,3). Sixth, the study was limited to patients with heart failure, so patient characteristics and outcomes may be different from other individuals in the ARIC study communities. Finally, while this study included a sample of hospitalizations from 4 U.S. communities, the results may not reflect practice patterns nationally.

Conclusions

Among a community sample of 4,345 heart failure–related hospitalizations, 85.1% of patients had LV function assessment and 59.7% of patients with LV systolic dysfunction were prescribed an ACE inhibitor or ARB at discharge, suggesting there is substantial opportunity for improvement in care delivered to patients hospitalized with heart failure. In particular, patients hospitalized with a principal diagnosis other than heart failure were less likely to receive care measures as compared to those with a principal diagnosis of heart failure, although compliance with performance measures showed a similar survival benefit in both groups. Because heart failure patients are commonly admitted for a variety of conditions, quality performance initiatives may have an opportunity to improve the care for many heart failure patients by targeting hospitalizations with both a principal and secondary heart failure diagnosis. Given the potential for reduced mortality with improved quality of care for the 3 million annual hospitalizations of heart failure patients for causes other than heart failure (9), the potential public health impact of such initiatives is great.

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Abbreviations and Acronyms

ACCF/AHA/AMA-PCPI	American College of Cardiology Foundation, American Heart Association, and American Medical Association–Physician Consortium for Performance Improvement
ACE	angiotensin-converting enzyme
ARB	angiotensin receptor blocker
CI	confidence interval
COPD	chronic obstructive pulmonary disease
CMS	Centers for Medicare and Medicaid Services
eGFR	estimated glomerular filtration rate
LV	left ventricular
OR	odds ratio

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Table 1

Baseline Characteristics of Hospitalized Heart Failure Patients With a Principal Diagnosis of Heart Failure and Those With Another Principal Diagnosis

	Principal Heart Failure Diagnosis n = 1,723	Other Principal Diagnosis n = 2,622	p Value
Age, yrs	75.1 (0.3)	75.2 (0.2)	0.91
Age category, yrs			0.29
55–64	19.5	19.8	
65–74	26.1	23.9	
75–84	33.8	36.6	
>85	20.7	19.6	
Female	53.0	52.6	0.85
Race			<0.001
White	63.0	72.0	
Black	33.9	23.5	
other	3.1	4.6	
Insurance			0.03
None	5.0	3.1	
Medicaid	4.0	4.7	
Medicare	16.3	15.1	
Other insurance	18.4	20.0	
Medicare/Medicaid	15.6	14.1	
Medicare/other	40.8	42.7	
ARIC classification			<0.001
Acute Decompensated	97.4	70.9	
Chronic	2.6	29.1	
Systolic HF	54.1	48.1	<0.001
Increased edema	67.7	47.6	<0.001
Admission SBP, mm Hg	146.0 (0.9)	137.8 (0.7)	<0.001
Discharge sodium, mml/l	138.6 (0.1)	138.7 (0.1)	0.51
Discharge eGFR, mL/min/1.73 m^2	46.6 (0.6)	51.8 (0.6)	<0.001
Medical history			
Anemia	29.0	29.9	0.61
Current smoker	13.4	15.8	0.06
COPD	30.6	39.1	<0.001
Asthma	6.6	9.9	0.001
Coronary heart disease	46.9	43.4	0.05

	Principal Heart Failure Diagnosis n = 1,723	Other Principal Diagnosis n = 2,622	p Value
Defibrillator	9.9	7.8	0.04
Hypertension	85.3	82.1	0.03
Diabetes	48.9	45.2	0.04
Dialysis	7.1	7.4	0.71
Stroke/TIA	17.7	20.9	0.02
Depression	14.4	18.0	0.008
Atrial fibrillation	36.8	35.5	0.43
Statin at discharge	47.2	45.9	0.44
Length of stay	5.7 (0.3)	8.7 (0.4)	<0.001

Values are mean (SE) or %.

ARIC = Atherosclerosis Risk in Communities; COPD = chronic obstructive pulmonary disease; eGFR = estimated glomerular filtration rate; HF = heart failure; TIA = transient ischemic attack; SBP = systolic blood pressure.

Table 2

Quality and Process Care Measures for Hospitalized Heart Failure Patients, by Principal Diagnosis

Care Measure	Patients Assessed for Measure	% Meeting Measure		p Value	Adjusted* Prevalence Ratio, Principal HF Versus Other
		Principal HF Diagnosis	Other Principal Diagnosis		
LV assessment	4,345	89.1	82.5	<0.0001	1.07 (1.04–1.10)
ACE inhibitor/ARB for LV dysfunction	2,275	64.1	56.3	0.002	1.11 (1.03–1.20)
β-blocker for LV dysfunction	2,275	81.4	77.9	0.08	1.03 (0.98–1.08)
Anticoagulation for atrial fibrillation	350	50.6	44.8	0.35	1.16 (0.89–1.52)
Aldosterone antagonist for LV dysfunction	1,919	19.8	15.0	0.02	1.35 (1.06–1.72)

Values are n, %, or prevalence ratio (95% confidence interval).

*Adjusted for age, gender, race, insurance, systolic blood pressure, estimated glomerular filtration rate, and history of coronary heart disease, diabetes, asthma, chronic obstructive pulmonary disease, dialysis, stroke, and atrial fibrillation.

ACE = angiotensin-converting enzyme; ARB = angiotensin receptor blocker; HF = heart failure; LV = left ventricular.

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Table 3

Relationship of Quality and Process Care Measures With 1-Year Mortality Following HF Hospitalization, by Principal Diagnosis

	Principal HF Diagnosis		Other Principal Diagnosis	
Care Measure	**Unadjusted**	**Adjusted***	**Unadjusted**	**Adjusted***
LV assessment	0.55 (0.36–0.83)	0.63 (0.41–0.98)	0.64 (0.47–0.86)	0.68 (0.49–0.94)
ACE inhibitor/ARB for LV dysfunction	0.51 (0.35–0.75)	0.67 (0.43–1.03)	0.67 (0.48–0.95)	0.76 (0.52–1.10)
β-blocker for LV dysfunction	0.52 (0.33–0.80)	0.51 (0.32–0.84)	0.49 (0.33–0.73)	0.48 (0.31–0.75)
Anticoagulation for atrial fibrillation	0.77 (0.33–1.81)	1.61 (0.60–4.34)	0.41 (0.17–0.99)	0.36 (0.13–0.95)
Aldosterone antagonist for LV dysfunction	0.83 (0.50–1.34)	0.79 (0.46–1.36)	0.65 (0.38–1.12)	0.57 (0.32–0.99)

Values are odds ratio (95% confidence interval).

*Adjusted for age, gender, race, insurance, systolic blood pressure, estimated glomerular filtration rate, sodium, presence of edema, statin at discharge, and history of coronary heart disease, diabetes, asthma, chronic obstructive pulmonary disease, stroke, and depression.

Abbreviations as in Table 2.

Table 4

Quality and Process Care Measures for Hospitalized HF Patients for 2 Alternative Definitions of Acute HF, Physician Documentation of HF as Reason for Hospitalization, and ARIC Adjudicated Acute HF

	% Meeting Measure				% Meeting Measure			
Care Measure	MD Notes HF Hospitalizations	HF Not Reason for Hospitalization	p Value	Adjusted* Prevalence Ratio, MD HF Versus Not	Adjudicated Acute HF	Adjudicated Chronic HF	p Value	Adjusted* Prevalence Ratio, Acute Versus Chronic HF
LV assessment	87.7	79.2	<0.0001	1.10 (1.06–1.14)	87.4	75.0	<0.0001	1.16 (1.11–1.22)
ACE inhibitor/ARB for LV dysfunction	62.3	52.9	0.0007	1.16 (1.05–1.27)	60.5	55.7	0.13	1.09 (0.98–1.21)
b-blocker for LV dysfunction	80.1	75.8	0.03	1.04 (0.98–1.10)	79.7	77.9	0.47	1.02 (0.96–1.09)
Anticoagulation for atrial fibrillation	46.6	49.3	0.70	0.98 (0.74–1.31)	47.9	44.1	0.64	1.23 (0.87–1.73)
Aldosterone antagonist for LV dysfunction	18.7	12.6	0.008	1.53 (1.14–2.06)	17.5	15.0	0.36	1.30 (0.93–1.81)

Values are % or prevalence ratio (95% confidence interval).

*Adjusted for age, gender, race, insurance, systolic blood pressure, estimated glomerular filtration rate, and history of coronary heart disease, diabetes, asthma, chronic obstructive pulmonary disease, dialysis, stroke, and atrial fibrillation.

Abbreviations as in Table 2.