



# Admission diagnoses among patients with heart failure: Variation by ACO performance on a measure of risk-standardized acute admission rates

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**Background** A key quality metric for Accountable Care Organizations (ACOs) is the rate of hospitalization among patients with heart failure (HF). Among this patient population, non-HF-related hospitalizations account for a substantial proportion of admissions. Understanding the types of admissions and the distribution of admission types across ACOs of varying performance may provide important insights for lowering admission rates.

**Methods** We examined admission diagnoses among 220 Medicare Shared Savings Program ACOs in 2013. ACOs were stratified into quartiles by their performance on a measure of unplanned risk-standardized acute admission rates (RSAARs) among patients with HF. Using a previously validated algorithm, we categorized admissions by principal discharge diagnosis into: HF, cardiovascular/non-HF, and noncardiovascular. We compared the mean admission rates by admission type as well as the proportion of admission types across RSAAR quartiles (Q1-Q4).

**Results** Among 220 ACOs caring for 227,356 patients with HF, the median (IQR) RSAARs per 100 person-years ranged from 64.5 (61.7-67.7) in Q1 (best performers) to 94.0 (90.1-99.9) in Q4 (worst performers). The mean admission rates by admission types for ACOs in Q1 compared with Q4 were as follows: HF admissions: 9.8 (2.2) vs 14.6 (2.8) per 100 person-years ( $P < .0001$ ); cardiovascular/non-HF admissions: 11.1 (1.6) vs 15.9 (2.6) per 100 person-years ( $P < .0001$ ); and noncardiovascular admissions: 42.7 (5.4) vs 69.6 (11.3) per 100 person-years ( $P < .0001$ ). The proportion of admission due to HF, cardiovascular/non-HF, and noncardiovascular conditions was 15.4%, 17.5%, and 67.1% in Q1 compared with 14.6%, 15.9%, and 69.4% in Q4 ( $P < .007$ ).

**Conclusions** Although ACOs with the best performance on a measure of all-cause admission rates among people with HF tended to have fewer admissions for HF, cardiovascular/non-HF, and noncardiovascular conditions compared with ACOs with the worst performance (highest admission rates), the largest difference in admission rates were for noncardiovascular admission types. Across all ACOs, two-thirds of admissions of patients with HF were for noncardiovascular causes. These findings suggest that comprehensive approaches are needed to reduce the diverse admission types for which HF patients are at risk. (*Am Heart J* 2019;207:19-26.)

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In the Medicare Shared Savings Program, several quality indicators are used to determine shared savings for Accountable Care Organizations (ACOs). One of these indicators is a measure of risk-standardized acute admission rates (RSAARs) among patients with heart failure (HF).<sup>1</sup> The measure captures acute unplanned admissions for any cause, rather than only admissions related to HF or other related ambulatory care sensitive conditions, with the goal of incentivizing coordinated, comprehensive, patient-centered care. In 2013, ACO performance on the measure of all-cause acute admissions for patients with HF varied substantially, yet little is

known about the reasons for admission and their association with ACO performance on the measure, which may help to guide strategies for quality improvement.<sup>1</sup>

ACO performance on an all-cause acute admission measure may be related to the pattern of admission diagnoses. Conceptually, ACOs that are successful in providing coordinated, patient-centered care might be better able to prevent and respond to the broad range of acute illnesses for which patients with HF may be vulnerable, which should have the effect of lowering rates of admissions for all types of conditions, including those directly related to HF, as well as admissions related to cardiovascular and noncardiovascular conditions. It is also plausible that successful ACOs focus their efforts on HF or cardiovascular care, which might have the effect of improving the overall health of their patients and increasing their resilience to other risks. Still, intensification of efforts focused on HF may unintentionally result in other conditions being ignored or ill supported. Knowledge about the patterns of admission types at best- and worst-performing ACOs can thus provide a starting point to better understand how successful ACOs may be acting to mitigate their population's risk. Accordingly, we compared patterns of admission diagnoses across ACOs with differing performance on the measure of all-RSAARs for patients with HF,<sup>1,2</sup> comparing the rates and proportions of admissions that were due to HF, cardiovascular, and noncardiovascular conditions among ACOs stratified into quartiles of performance on the HF admission quality measure.

## Methods

### Data sources and study population

We assessed care quality performance for patients with HF using a risk-standardized measure of acute admission rates that was adopted by the Medicare Shared Savings Program in 2015.<sup>1</sup> Briefly, to identify the cohort, we used 2011-2012 Medicare part A and part B claims data from the Chronic Conditions Data Warehouse for 100% of Medicare fee-for-service beneficiaries. We included patients who were continuously enrolled in FFS Medicare, were 65 years and older, and had a diagnosis of HF, which was defined as either 1 or more hospital claims with a principal discharge diagnosis code for HF or 2 claims (inpatient or outpatient) with codes for HF in any position. We excluded patients with cardiac mechanical assist devices consistent with the quality measure.<sup>1</sup> We used 2013 Medicare Part A data to assess the outcome of admission.

### ACO performance

ACOs vary in geographic location, rurality, size, composition of physician types, and hospital inclusion. We calculated the RSAARs for patients with HF for each

of the 220 ACOs participating in the Medicare Shared Savings Program in 2013. The outcome is the number of unplanned admissions per 100 person-years. To determine whether an admission was planned, we used the principal discharge diagnosis associated with the admission and excluded admissions that were deemed to be planned based on an algorithm that was previously validated in measures of acute readmissions and has been adopted by Centers for Medicare and Medicaid Services (CMS) in its ACO measures.<sup>3</sup> The measure score is calculated using a hierarchical negative binomial model that accounts for the clustering of patients within ACOs and variation in sample size, and estimates the number of unplanned admissions per 100 person-years as a function of patient age, indicators of HF disease severity, and 20 other comorbidity indicators using an ACO-level random effects term. The measure score is the ratio of the *predicted* number of admissions given the ACO's patient mix (based on the risk factors and taking into account sample size) over the *expected* number of admissions (based on an average ACO with a similar mix of patients) multiplied by the national rate of admissions among all patients with HF under the Medicare Fee-for-Service plan.<sup>1</sup>

We stratified ACOs by their scores on this measure into quartiles, with Q1 and Q4 indicating ACOs with the lowest (best performance) and highest (worst performance) risk standardized admission rates, respectively.

### Classification of admission diagnoses

We classified admission types by *International Classification of Diseases, Ninth Revision, Clinical Modification*, principal discharge diagnoses using a modified version of the Hierarchical Condition Category (HCC) classification system developed by Pope et al for CMS.<sup>4</sup> The HCC system groups more than 15,000 *International Classification of Diseases, Ninth Revision, Clinical Modification*, diagnoses into 189 clinically coherent and mutually exclusive categories. However, it was previously observed that nearly 90% of the 189 HCC groups each account for less than 1% of all Medicare Fee-for-Service readmissions. Therefore, Dharmarajan et al.<sup>7</sup> further consolidated the 189 HCCs into 30 modified condition categories by grouping related diagnoses with similar clinical presentations to describe readmissions after HF, acute myocardial infarction (MI), and pneumonia hospitalizations. We used this system to group all acute unplanned admissions into 3 categories: (1) HF, (2) due to cardiovascular conditions but non-HF, and (3) due to any noncardiovascular conditions. The list of diagnoses constituting the 30 modified condition categories is available in the "Results" section (Table II).

### Statistical analysis

We characterized the sociodemographic attributes and clinical comorbidities of the population of patients with HF cared for in ACOs, stratified by quartiles based on their

performance on the risk-standardized acute admission measure, using weighted analysis of variance to compare differences. To assess differences in the relative admission types among ACOs in different quartiles, we counted all admissions in the measurement year. We first identified the number (per 100 person-years) and proportion (%) of admissions for each of the 30 modified CMS condition categories out of all acute admissions at each ACO. We also calculated both the mean number (per 100 person years) and the proportion (%), weighted by number of ACO enrollees) of each admission type among ACOs within each quartile. We then compared the pattern of the 10 most common admission diagnoses as well as the relative proportions of admissions due to HF, cardiovascular/non-HF, and noncardiovascular causes across ACO performance quartiles. We again used analysis of variance to compare differences across the ACO performance quartiles, with each observation weighted by ACO volume.

Statistical Analyses were conducted using SAS version 9.3 (SAS Institute Inc, Cary, NC). A prespecified  $P$  value of  $< .05$  was used as the level of significance. The study was approved by the Institutional Review Board of Yale School of Medicine.

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## Results

### Study population and ACO performance

We identified 169,383 acute, unplanned admissions among 227,356 patients with HF who were cared for by 220 Medicare Shared Savings ACOs in 2013. The median (IQR) RSAARs per 100 person-years for ACOs in Q1, Q2, Q3, and Q4 were 64.5 (61.7-67.7), 74.3 (72.5-76.7), 83.3 (80.7-85.4), and 94.0 (90.1-99.9), respectively.

There were some notable differences in demographic characteristics of patients with HF across ACO performance categories (Table 1). ACOs with the best versus

worst performance on the risk-standardized acute admission measure tended to have more male patients (mean [SE]: 53.0% [3.9] in Q1 vs 49.6% [3.4] in Q4,  $P < .001$ ), fewer black patients (mean [SE]: 6.1% [6.8] in Q1 vs 12.8% [15.2] in Q4,  $P < .05$ ), and fewer patients with dual Medicare-Medicaid insurance (mean [SE]: 14.7% [14.8] in Q1 vs 25.1% [15.3] in Q4,  $P = .002$ ). There were no differences in the average age (79.7 years) and mean number of patients per ACO (SE) (1033 [1011]) across ACO groups.

There were also differences in the prevalence of some of the comorbidities across ACO performance groups. These included high-risk cardiovascular conditions (acute MI, unstable angina and other acute ischemic heart disease, hypertensive heart and renal disease or encephalopathy, and vascular disease with complications), which were prevalent in 32.7% [5.4] of patients enrolled in ACOs in Q1 vs 35.7% [4.0] of patients enrolled in ACOs in Q4,  $P = .01$ , dementia (18.3% [4.8] vs 25.9% [6.2],  $P < .001$ ), and psychiatric illness/substance abuse (32.9% [6.1] vs 40.3% [4.9],  $P < .001$ ). There were no differences across ACO performance groups in low-risk cardiovascular conditions (angina pectoris, old MI, coronary atherosclerosis/other chronic ischemic heart disease, other and unspecified heart disease, vascular disease, and other circulatory disease), arrhythmia, structural heart disease, advanced cancer, diabetes with complications, infectious immune disorders, kidney disease, liver disease, neurologic disease, other advanced organ failure, cardiac resynchronization therapy/implantable cardioverter defibrillator/pacemaker, or iron deficiency anemia. Finally, best-performing ACOs tended to have lower unadjusted mortality rates than worst-performing ACOs (mean [SE]: 13.6% [2.8] in Q1 vs 19.7% [4.0] in Q4,  $P < .001$ ). However, these mortality rates need to be interpreted with caution because they are not risk standardized and thus do not account for differences in case mix.

### Common admission diagnoses by ACO performance

The distribution of the 10 most prevalent admission categories was similar across ACOs in all performance quartiles. Notably, the mean (SE) proportion of admissions due to HF was 15.4% (2.3), 16.1% (2.1), 15.7% (1.9), and 14.6% (3.0) ( $P < .007$ ) for ACOs in the Q1, Q2, Q3, and Q4 performance categories, respectively. Pneumonia, septicemia/shock, and renal disorders were the next most prevalent admission diagnoses in all ACO performance groups (Figure 1).

### Cardiovascular and noncardiovascular admissions by ACO performance

ACOs in the best performance quartiles had lower admission rates for cardiovascular (HF or non-HF related) and noncardiovascular conditions with a consistent trend showing an increase in admission rates across ACO performance quartiles based on the risk-standardized

**Table 1.** Characteristics of patients with heart failure cared for by ACOs with varying RSAARs

Patients with HF	Total cohort	Q1 (best performance)	Q2	Q3	Q4 (worst performance)	P value
Number of ACOs	220	55	55	55	55	
Median RSAAR score per 100 person-years	65	65	74	83	94	
Number of patients (mean [SE])	1033.4 (1010.8)	864.3 (659.8)	1173.1 (916.5)	1044.6 (1010.6)	1051.7 (1340.7)	.4574
Sociodemographic factors (mean [SE])						
Mean age	79.7 (1.4)	79.3 (1.3)	79.8 (1.3)	79.9 (1.4)	79.8 (1.4)	.0783
Male	51.4 (4.0)	53.0 (3.9)	51.6 (4.1)	51.2 (3.7)	49.6 (3.4)	<.001
Race						
White	85.2 (16.2)	86.5 (15.9)	86.3 (14.2)	86.3 (15.7)	81.8 (18.5)	.3465
Black	9.7 (12.5)	6.1 (6.8)	9.0 (10.4)	10.8 (15.0)	12.8 (15.2)	.0386
Other	5.1 (10.4)	7.4 (15.1)	4.7 (10.1)	2.9 (4.3)	5.4 (8.9)	.1642
Medicare-Medicaid insured	19.3 (14.8)	14.7 (14.8)	17.9 (15.0)	19.6 (12.2)	25.1 (15.3)	.0021
Clinical factors (mean [SE])						
High-risk cardiovascular conditions*	34.1 (4.8)	32.7 (5.4)	33.9 (4.9)	34.3 (4.5)	35.7 (4.0)	.0122
Low-risk cardiovascular conditions†	85.0 (3.7)	84.5 (3.7)	85.3 (3.8)	84.4 (3.7)	85.7 (3.6)	.2153
Arrhythmia	64.7 (5.9)	62.9 (7.1)	65.3 (4.6)	66.1 (5.9)	64.5 (5.3)	.0296
Structural heart disease	41.3 (7.9)	42.1 (7.9)	43.9 (8.7)	40.6 (7.2)	38.7 (6.8)	.0048
Advanced cancer	7.5 (1.7)	7.5 (1.5)	7.7 (2.1)	7.5 (1.7)	7.3 (1.4)	.723
Dementia	21.8 (6.0)	18.3 (4.8)	21.5 (4.6)	21.6 (5.8)	25.9 (6.2)	<.001
Diabetes with complications	53.1 (8.0)	54.1 (10.2)	52.0 (7.5)	51.0 (6.1)	55.2 (7.0)	.0256
Dialysis	3.3 (1.7)	3.1 (1.5)	3.3 (1.7)	3.1 (1.4)	3.8 (2.0)	.0831
Disability/frailty	22.6 (4.6)	20.5 (3.9)	22.2 (4.0)	22.0 (4.0)	25.5 (4.9)	<.0001
Gastrointestinal and genitourinary disorders	32.6 (4.6)	31.8 (4.3)	32.3 (4.8)	32.0 (4.2)	34.1 (4.8)	.035
Hematology	16.3 (4.2)	16.3 (4.7)	16.6 (4.1)	15.5 (3.5)	16.9 (4.5)	.3346
Infection and immune disorders	7.0 (1.7)	6.8 (1.6)	7.2 (1.9)	6.8 (1.8)	7.2 (1.5)	.3697
Kidney disease	41.4 (6.2)	40.7 (7.0)	41.7 (7.0)	40.6 (4.8)	42.6 (5.7)	.2668
Liver disease	2.4 (1.1)	2.5 (1.1)	2.4 (1.1)	2.1 (0.9)	2.6 (1.1)	.0883
Neurological	45.4 (5.8)	44.6 (5.9)	45.5 (5.9)	44.3 (5.6)	47.1 (5.4)	.0561
Psychiatric illness/substance abuse	36.9 (5.9)	32.9 (6.1)	36.6 (5.0)	37.8 (5.2)	40.3 (4.9)	<.0001
Pulmonary disease	59.2 (5.1)	57.9 (5.1)	58.8 (5.4)	58.7 (4.4)	61.5 (4.7)	.0011
Other advanced organ failure	21.3 (4.7)	20.2 (6.0)	21.7 (3.8)	20.9 (3.6)	22.3 (4.7)	.1012
CRT/ICD/pacemaker	23.6 (4.9)	24.4 (5.3)	24.5 (4.7)	23.3 (5.4)	22.4 (4.0)	.0788
Iron deficiency anemia	53.7 (8.0)	52.8 (9.1)	53.6 (8.0)	52.3 (6.2)	56.3 (7.8)	.04
Major organ transplant	0.4 (0.5)	0.5 (0.3)	0.4 (0.3)	0.5 (0.7)	0.4 (0.3)	.53
Other organ transplant	1.0 (0.6)	1.0 (0.5)	1.0 (0.5)	1.1 (0.8)	0.9 (0.5)	.3718
2013 Unadjusted mortality (mean [SE])	16.8 (3.8)	13.6 (2.8)	16.4 (2.6)	17.7 (2.6)	19.7 (4.0)	<.001

CRT, cardiac resynchronization therapy; ICD, implantable cardioverter defibrillator.

\* High-risk cardiovascular conditions: acute MI, unstable angina and other acute ischemic heart disease, hypertensive heart and renal disease or encephalopathy, and vascular disease with complications.

† Low-risk cardiovascular conditions: angina pectoris, old MI, coronary atherosclerosis/other chronic ischemic heart disease, other and unspecified heart disease, vascular disease, and other circulatory disease.

acute admission measure. For HF admissions, the mean rates per 100 person-years were as follows: Q1, 9.8 (SE 2.2); Q2, 12.1 (1.8); Q3, 13.1 (1.7); and Q4, 14.6 (2.8) ( $P$  value for trend < .0001) (Table II). The mean rate of cardiovascular/non-HF admissions per 100 person-years also increased across ACO performance quartile: Q1, 11.1 (1.6); Q2, 13.1 (1.5); Q3, 14.0 (1.5); and Q4, 15.9 (2.6) ( $P$  value for trend < .0001). The mean admission rates per 100 person-years for noncardiovascular conditions, which had the highest rates across all quartiles, were Q1 42.7 (5.4); Q2, 50.2 (4.9); Q3, 56.4 (5.6); and Q4, 69.5 (11.3) ( $P$  value for trend < .0001).

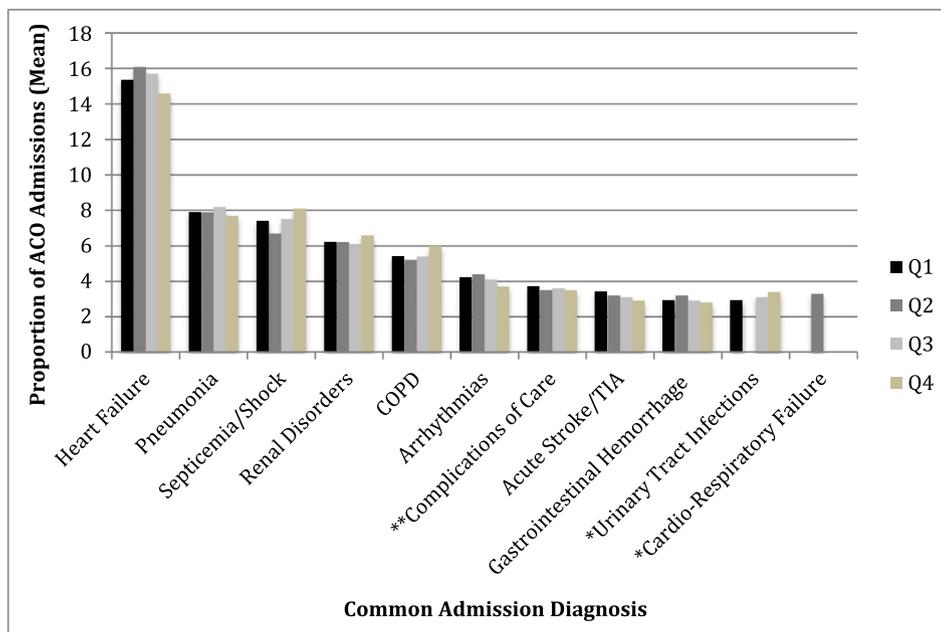
The proportion of admissions types in each quartile showed similar trends, although the differences were more modest. Overall, hospitalizations due to cardiovascular diagnoses (HF or non-HF-related) accounted for about a third of admissions, whereas noncardiovascular diagnosis

accounted for more than two-thirds of admissions across all ACO performance groups. There was a progressively lower proportion of cardiovascular/non-HF admissions across ACO performance groups: Q1, 17.5% (SE = 2.3); Q2, 17.4% (SE = 1.8); Q3, 16.8% (SE = 1.7); and Q4, 15.9% (SE = 2.1) ( $P$  value for trend < .0001) (Figure 2). Additionally, there was a modest increase in the proportion of noncardiovascular admission diagnoses across ACO performance groups: Q1, 67.1% (SE = 3.3); Q2, 66.5% (SE = 2.9); Q3, 67.5% (SE = 2.8); and Q4, 69.4% (SE = 3.1) ( $P$  value for trend < .0001).

## Discussion

In this national study of HF patients cared for by Medicare Shared Savings Program ACOs, the patterns of admission types varied based on ACO performance on a

Figure 1



Top admission diagnoses across quartiles of ACOs with varying RSAARs. \*ACO stands for accountable care organization. \*\*Q1 and Q4 indicating best and worst performance, respectively. Admission diagnoses were classified into 30 modified condition categories. \*The 10th most common admission diagnosis was different for Q2 (cardiorespiratory failure) as compared to the other performance quartiles (urinary tract infections); as such, they are illustrated as 2 distinct bars. \*\*Complications of care include poisoning and allergic reactions, major complications of medical care and trauma, and other complications of medical care.

measure of acute, unplanned risk-standardized admission rates. Across all ACOs, HF was the most common admission diagnosis followed by pneumonia, septicemia/shock, and renal disorders. However, HF admissions accounted for fewer than 1 in 6 acute hospitalizations, and there was little variation in the proportion of admissions due to HF across ACOs with best and worst performance. Conversely, greater than two-thirds of admissions among patients with HF were for noncardiovascular conditions, and the rates for these types of admissions accounted for the difference in performance between ACOs. Although the proportion of noncardiovascular-related admissions was only 2.3% lower among ACOs in Q1 compared with Q4, this translated to approximately 17,000 fewer admissions for noncardiovascular conditions and accounted for the observed difference in ACO performance. Efforts to reduce noncardiovascular admissions not only may result in improved patient outcomes and performance on the measure of acute admission rates but also may lower health care costs among ACOs in Q4. Additionally, the proportion of admissions for cardiovascular/non-HF causes was progressively lower among ACOs with worse performance. Moreover, the proportions of admissions due to HF were also slightly lower in Q4

than in Q1. These findings support the hypothesis that ACOs with worse performance focus more on preventing cardiovascular causes of admissions and less on care for noncardiovascular conditions. This is also in line with our conclusion that highly coordinated and comprehensive care strategies are needed to prevent the largest number of admissions. Still, more studies are needed to understand whether the observed proportional differences in admissions reflect meaningful differences in care delivery or quality.

Studies evaluating the distribution of diagnoses for acute admissions among patients with HF cared for by ACOs are lacking, although our findings extend prior studies focused on the reasons for readmissions after incident admission for HF.<sup>5,6</sup> In Medicare<sup>7</sup> and non-Medicare<sup>8</sup> populations, HF accounts for a higher proportion of 30-day readmissions after an index HF admission than it does for index hospitalizations among patients with HF.<sup>9,10</sup> In a study including Medicare and other payer populations, Davis et al found that one-third of 30-day readmissions following a hospitalization for HF were due to HF and that slightly over half of readmissions were for noncardiovascular causes.<sup>11</sup> In another study of non-Medicare patients, over 40% of 30-day readmissions were for HF, and only 36% of all readmissions were due to noncardiovascular causes.<sup>12</sup> A

**Table II.** Proportions of cardiovascular and noncardiovascular admissions among ACOs with different RSAARs

Discharge diagnosis, mean % (SE)	Q1 n = 55	Q2 n = 55	Q3 n = 55	Q4 n = 55	P value
HF	15.4 (2.3)	16.1 (2.1)	15.7 (1.9)	14.6 (3.0)	.0069
Cardiovascular/non-HF	17.5 (2.3)	17.4 (1.8)	16.8 (1.7)	15.9 (2.1)	<.0001
Arrhythmias and conduction disorders	4.2 (1.0)	4.4 (1.1)	4.1 (1.0)	3.7 (0.9)	.001
Acute stroke/transient ischemic attack	3.4 (0.9)	3.2 (0.7)	3.1 (0.6)	2.9 (0.7)	.0091
Acute MI	2.7 (0.9)	2.4 (0.7)	2.9 (0.9)	2.4 (0.8)	.015
Other peripheral vascular disease	2.1 (0.7)	2.1 (0.5)	2.2 (0.6)	2.2 (0.6)	.7194
Chest pain	1.1 (0.8)	1.2 (0.5)	1.0 (0.5)	1.1 (0.5)	.3705
Chronic angina and coronary artery disease	1.2 (0.6)	1.2 (0.4)	0.9 (0.4)	0.9 (0.4)	<.0001
Pulmonary embolism/deep venous thrombosis	0.9 (0.5)	0.9 (0.4)	0.9 (0.3)	0.9 (0.3)	.7911
Syncope	0.8 (0.6)	0.8 (0.5)	0.8 (0.3)	0.8 (0.4)	.7468
Other cardiac disease including congenital heart and hypertensive disease	0.7 (0.5)	0.7 (0.4)	0.7 (0.4)	0.7 (0.3)	.6531
Valvular/rheumatic heart disease	0.3 (0.2)	0.3 (0.2)	0.3 (0.2)	0.2 (0.1)	.0005
Unstable angina and other acute ischemic heart disease	0.1 (0.2)	0.1 (0.1)	0.1 (0.2)	0.1 (0.1)	.3399
Noncardiovascular	67.1 (3.3)	66.5 (2.9)	67.5 (2.8)	69.4 (3.1)	<.0001
Other admitting diagnoses	18.9 (2.1)	19.2 (2.2)	19.3 (2.4)	19.5 (2.3)	.6177
Pneumonia including aspiration pneumonitis	7.9 (2.0)	7.9 (1.8)	8.2 (1.7)	7.7 (1.9)	.6188
Septicemia/shock	7.4 (3.1)	6.7 (2.3)	7.5 (2.2)	8.1 (3.0)	.0517
Renal disorders including renal failure and fluid, electrolyte, and acid-base abnormalities	6.2 (1.3)	6.2 (1.0)	6.1 (1.3)	6.6 (1.1)	.0008
COPD/asthma	5.4 (1.7)	5.2 (1.4)	5.4 (1.6)	6.0 (1.7)	.0408
Complications of care	3.7 (1.0)	3.5 (0.8)	3.6 (1.1)	3.5 (0.8)	.4483
Gastrointestinal hemorrhage	2.9 (0.7)	3.2 (0.7)	2.9 (0.7)	2.8 (0.7)	.0355
Urinary tract infection and urinary system complaints	2.9 (1.0)	2.8 (0.7)	3.1 (1.0)	3.4 (0.9)	.0006
Cardiorespiratory failure	2.9 (1.3)	3.3 (1.2)	2.7 (1.0)	2.8 (0.9)	.0173
Hip fracture	2.2 (0.8)	2.1 (0.8)	2.4 (0.7)	2.2 (0.7)	.3375
Cellulitis	2.1 (0.7)	1.9 (0.5)	2.1 (0.6)	2.2 (0.6)	.0296
Anemia	1.4 (0.6)	1.4 (0.5)	1.3 (0.6)	1.5 (0.5)	.0797
Diabetes and its complications	1.3 (0.6)	1.2 (0.5)	1.2 (0.4)	1.5 (0.6)	.0187
Other lung disorders including acute, congenital, and unspecified lung abnormalities	0.7 (0.4)	0.8 (0.4)	0.7 (0.4)	0.7 (0.4)	.3273
Pleural effusion/pneumothorax	0.6 (0.3)	0.5 (0.3)	0.5 (0.2)	0.5 (0.2)	.0743
Fibrosis of lung and other chronic lung disorders	0.3 (0.4)	0.3 (0.2)	0.3 (0.2)	0.2 (0.2)	.7874
Primary cancer of the trachea, bronchus, lung and pleura	0.3 (0.3)	0.2 (0.2)	0.2 (0.2)	0.2 (0.2)	.6673

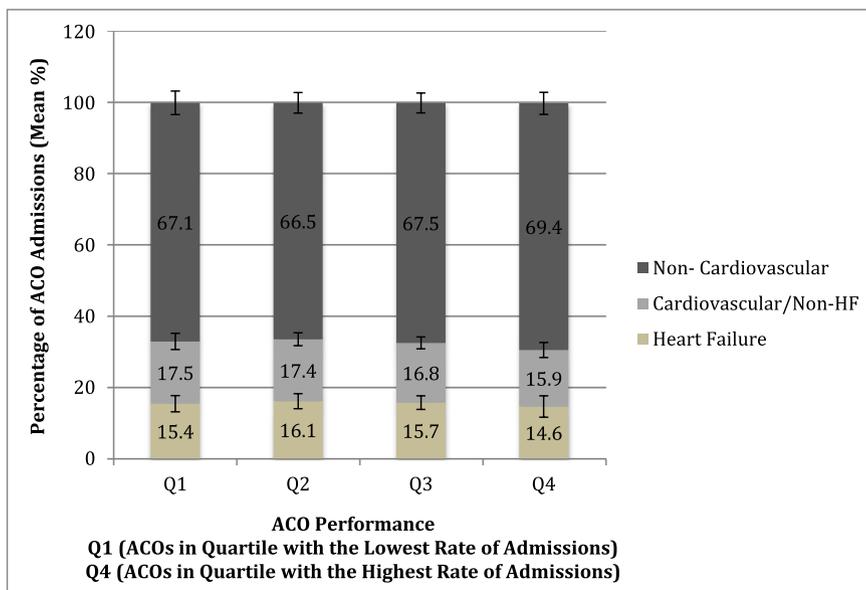
COPD, chronic obstructive pulmonary disease.

recent study which included both Medicare and non-Medicare patients and used the Get With the Guidelines HF Registry found that, among patients hospitalized for HF, those who had an increased number of noncardiovascular comorbidities had a greater risk of incurring a 30-day readmission for noncardiovascular causes than for HF. This study also found that, over the past decade, there has been a marked increase in the number of noncardiovascular comorbidities among patients with HF.<sup>13</sup> These findings are consistent with our cohort, which is older and frequently has multiple comorbid disease. In our cohort, only 16% of all admissions among patients with HF were for an HF exacerbation, and two-thirds of all admissions were for noncardiovascular causes. The finding that best-performing ACOs had fewer admissions due to noncardiovascular conditions is not surprising. Prior studies of hospital-level performance variation on measures of readmission and mortality among patients with HF and other cardiovascular conditions have shown that the best-performing hospitals were more likely to engage in structural efforts to improve quality such as supporting a collaborative culture with emphasis on learning and problem solving<sup>14</sup> and multidisciplinary care coordina-

tion<sup>5,15</sup> rather than specific disease interventions.<sup>6</sup> Additionally, this more comprehensive approach to the care of older patients with HF has previously been recommended and is part of the clinical practice guidelines for managing cardiac patients with other comorbidities.<sup>16,17</sup>

Although it is possible that focused, high-quality HF care may improve overall health and increase patients' resilience to other acute illnesses—thereby lowering the risk of both HF and non-HF-related admissions—it is also the case that older patients with heart failure have multiple comorbidities which may complicate the ability to optimize care.<sup>18</sup> Moreover, focusing only on 1 condition may worsen another condition. Findings by Redelmeier et al suggest that if 1 chronic disease consumes most medical attention, the treatment of other diseases in the same individual might be neglected.<sup>19</sup> Although patients with HF are at risk for HF exacerbations and treatment adverse effects, such as fluid and electrolyte disturbances, other conditions may be equally or more important. For example, frailty,<sup>20,21</sup> hemodynamic instability,<sup>22</sup> cognitive impairments,<sup>23,24</sup> compromised immune systems, and multimorbidity<sup>25-27</sup> place patients at risk for admissions not related to HF. A recent study by Manemann et al found that

**Figure 2**



Proportions (%) of admissions for HF, cardiovascular/non-HF, and noncardiovascular causes among ACOs with varying RSAARs. Admission diagnoses were classified into 30 modified condition categories and then further classified into the 3 categories. Error bars denote standard error.

although cardiovascular-related conditions are the most common type of comorbid conditions among patients with HF, other physical and mental conditions such as chronic obstructive pulmonary disease and depression are more strongly associated with hospitalization and death.<sup>10</sup> These observations suggest that, to reduce admissions in the HF population, ACOs must develop high-quality, responsive systems of care that are seamlessly coordinated across primary care and specialty services.

Our study has several limitations. The patient population included in the measure was restricted to Medicare beneficiaries aged 65 years and older. Admission types and their relative proportions may be different for younger patients with fewer or different comorbidities, potentially rendering these findings less generalizable to younger populations. However, patients 65 years and older comprise the majority of patients with HF.<sup>28</sup> Second, although the measure scores are risk standardized, the rates by admission types are not. An important question is whether differences in admission types are related to differences in the clinical characteristics of patients cared for by ACOs in Q1 versus Q4. Patients in best-performing ACOs (Q1) tended to have fewer noncardiovascular comorbidities than patients cared for by worst-performing ACOs (Q4). However, the risk-standardized models used to measure performance account for differences in case mix. Specifically, the expected rate accounts for differences in case mix and sample size, and we assessed the model performance prior to its adaptation by the Medicare Shared Savings

Program in 2015.<sup>1</sup> Additionally, we observed examples in our data that the excess risk of admissions was not due to baseline risk factor prevalence. For example, the prevalence of kidney disease did not differ between ACOs in Q1 through Q4, yet the rate of admissions for renal disorders across ACO performance groups varied significantly. Furthermore, although we acknowledge that nonclinical, social risk factors may impact admission rates and residual confounding is possible, we did not adjust for differences in sex, race, and Medicaid status because doing so could mask underlying disparities. Third, this study did not assess the influence of ACO characteristics on measure performance or types of admissions. We acknowledge that features such as the rurality of the ACO may influence performance, although many other ACO characteristics (eg, number of specialists) are under the control of ACOs. More work is needed to understand the influence of modifiable and nonmodifiable characteristics of ACOs, and their relationship to outcomes. Lastly, the measure includes incident admissions as well as 30-day readmissions (ie, admissions of patients who were discharged in the preceding 30 days), and in this study, we did not differentiate discharge diagnoses associated with admissions versus readmissions. However, understanding the various types of admissions and readmissions is important for designing care programs that are effective in both phases, pre- and post-index hospitalization. Importantly, our study excluded admissions that were planned, as these may not reflect quality of care. Finally, as our study was

observational, we could not rule out unobserved confounders that might influence admission causes and rates.

In summary, our study found that, across all ACOs, two-thirds of admissions among patients with HF were for noncardiovascular causes and the ACOs with the lowest admission rates had a lower proportion of noncardiovascular admissions compared to ACOs with the highest admission rates. These findings suggest that ACOs that focus their efforts solely on reducing admissions related to HF exacerbations may have limited impact on overall acute admission rates; a more comprehensive, patient-centered approach may be needed to prevent the wide array of acute conditions for which patients with HF are at risk.

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