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Relation of Dyspnea Severity on Admission for Acute Heart Failure With Outcomes and Costs

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Abstract

Hospitalization for heart failure (HF) is frequently related to dyspnea, yet associations between dyspnea severity, outcomes, and health care costs are unknown. We aimed to describe characteristics of patients hospitalized for acute HF by dyspnea severity and to examine associations between dyspnea severity, outcomes and costs. We linked registry data for patients hospitalized for HF with Medicare claims to evaluate dyspnea and outcomes among patients 65 years and older. We classified patients by patient-reported dyspnea severity at admission. Outcomes included length of stay, mortality 30 days after admission, and days alive and out of the hospital, readmission, and Medicare payments 30 days after discharge. Of 48,616 patients with acute HF and dyspnea, 4022 (8.3%) had dyspnea with moderate activity, 19,619 (40.3%) with minimal activity, and 24,975 (51.4%) at rest. Patients with dyspnea with minimal activity or at rest had greater comorbidity, including renal insufficiency. Greater severity of baseline dyspnea was associated with mortality (moderate activity, 6.3%; minimal activity, 7.6%; at rest, 11.6%) and heart failure readmission (7.2%, 9.0%, and 9.4%). After multivariable adjustment, dyspnea at rest was associated with greater 30-day mortality and heart failure readmission, fewer days alive and out of the hospital, longer length of stay, and higher Medicare payments, compared to dyspnea with moderate activity. In conclusion, dyspnea at rest on presentation was associated with greater mortality, readmission, length of stay, and health care costs among patients hospitalized with acute HF.

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Keywords

Dyspnea; Heart Failure; Mortality; Patient Outcome Assessment; Patient Readmission

Heart failure (HF) is a common and costly condition and a leading cause of hospitalization worldwide.[1–3] Many patients hospitalized with acute HF have dyspnea either at rest or with minimal exertion.[4] Despite dyspnea being a common presenting symptom, little is known about how it relates to patient outcomes. Investigations related to dyspnea in hospitalized patients with HF have focused primarily on symptom relief. Dyspnea relief has been used as an end point for establishing regulatory approval for therapies, and in some analyses has been associated with improved outcomes.[5–7] Notably, dyspnea relief has been linked with improved clinical outcomes in clinical trials of therapeutic agents,[8] but in other trials there has been a disconnect between dyspnea relief and clinical outcomes.[9] Characteristics, outcomes, and associated costs among patients with acute HF in clinical practice have not been well characterized by baseline dyspnea severity.

Methods

We obtained hospitalization data from the Acute Decompensated Heart Failure National Registry (ADHERE) of patients hospitalized with acute HF.[10] We linked the ADHERE data to Medicare inpatient and denominator files[11] using methods described previously.[12,13] We included patients 65 years or older who had a registry hospitalization for acute HF between January 1, 2001, and March 31, 2006, that was linked to fee-for-service Medicare claims data. Eligible patients lived in the United States at the time of the index admission and were enrolled in fee-for-service Medicare for at least 6 months before the index admission (n=78,373). We excluded patients who were admitted on an elective basis (n=5962). Patients for whom dyspnea severity at admission was not documented in the registry (n=16,061) and those who did not have dyspnea at admission (n=7734) were excluded from the analysis (Figure 1). These excluded patients were generally similar to the study population (Supplemental Table 1). Patients who died in the hospital, left against medical advice, or were discharged or transferred to another short-term hospital or hospice were excluded from the measurement of 30-day readmission and clinical status at discharge. Patients in the postdischarge cohort who enrolled in a Medicare managed care plan during the 30 days after discharge from the index hospitalization were excluded from the measurement of days alive and out of the hospital and Medicare payments.

The study variable of interest was *dyspnea severity* on admission (at time of initial presentation). The dyspnea severity characterization in ADHERE was based on patient self-reported symptom severity (dyspnea with moderate activity, dyspnea with minimal activity, or dyspnea at rest) as obtained by the clinicians directly involved in their routine clinical care and as documented in the medical record. A specific research instrument or standardized questionnaire was not utilized. The outcomes of interest were mortality during the index hospitalization and at 30 days after admission; length of stay and clinical status at discharge; and 30-day postdischarge days alive and out of the hospital, readmission (HF and all-cause), and Medicare payments. We determined all-cause mortality based on death dates

in the Medicare denominator files. Length of stay and in-hospital mortality were based on Medicare claims for the index hospitalization. Clinical status at discharge was categorized as asymptomatic, improved but still symptomatic, or other/unknown, as recorded in the registry based on patient-report. Total days alive and out of the hospital in the 30 days after discharge was determined based on the date of death in the Medicare denominator files and hospitalization dates in Medicare inpatient files. We identified readmission based on subsequent inpatient Medicare claims. Readmission for HF was based on subsequent inpatient claims with a primary diagnosis of HF (*ICD-9* diagnosis code 428.x, 402.x1, 404.x1, or 404.x3). We calculated time to readmission as the number of days from the index discharge date to the subsequent admission date. Medicare payments in the 30 days after discharge were determined based on payments for inpatient, outpatient, and carrier claims. Payments were reported in 2010 US dollars with inflation adjustment using the Consumer Price Index for medical care.

We described baseline characteristics of the study population by dyspnea severity at admission using frequencies with percentages for categorical variables and medians with interquartile ranges (IQRs) for continuous variables. We tested for differences between the groups using chi-square tests for categorical variables and Kruskal-Wallis tests for continuous variables. For variables that had low rates of missingness (ie, less than 5% of records), we imputed continuous variables to the overall median value, dichotomous variables to “no,” and multichotomous variables to the most frequent categorical value. For variables with greater than 5% missingness (ie, smoking status, BNP level, race, and ejection fraction), we treated the missing values as a separate category.

We present the observed outcomes by dyspnea severity at admission. For in-hospital mortality and clinical status at discharge, we tested for differences between groups using chi-square tests. For length of stay, days alive out of the hospital at 30 days, and Medicare payments at 30 days, we tested for differences between groups using Kruskal-Wallis tests. For 30-day mortality, we calculated cumulative incidence based on Kaplan-Meier estimates and tested for differences between groups using log-rank tests. For readmission, we calculated cumulative incidence at 30 days based on estimates from the cumulative incidence function, which accounts for the competing risk of mortality, and we tested for differences between groups using Gray tests.

We estimated the unadjusted and adjusted associations between dyspnea severity at admission and the outcomes of interest. In the unadjusted model, dyspnea severity was the only predictor. In the adjusted model, we controlled for baseline covariates, medications at discharge, and the year of the index admission (see Table 3 footnote for variable list). With the large number of events in each analysis, there was no over-fitting problem with the adjustment variables. We used a linear mixed model for days alive out of the hospital at 30 days, Cox proportional hazard models for 30-day mortality and readmission, generalized linear mixed models with a Poisson distribution and log link for Medicare payments, and a logistic regression model for in-hospital mortality. Finally, we assessed associations between other baseline covariates and dyspnea severity using a generalized logistic regression model. We report the estimated odds ratios (ORs) associated with each characteristic for comparisons of the dyspnea categories. For all models, significance tests

and confidence intervals (CIs) were based on robust standard errors to account for the clustering of patients by hospital. Because of the large number of comparisons in the analysis, we used a 2-tailed $\alpha = 0.01$ to establish statistical significance and we report 99% CIs. We used SAS version 9.3 (SAS Institute Inc, Cary, NC) for all analyses. The institutional review board of the Duke University Health System approved the study.

Results

Of 48,616 patients with acute HF and dyspnea, 4022 (8.3%) had dyspnea with moderate activity, 19,619 (40.3%) had dyspnea with minimal activity, and 24,975 (51.4%) had dyspnea at rest. Thus, the group with dyspnea with moderate activity represented a comparatively lower percentage of the study population. Table 1 shows the baseline characteristics of the 3 groups. Patients with dyspnea at rest had more advanced chronic kidney disease (ie, stages 3–5) than patients with dyspnea with moderate activity. The dyspnea at rest group also had the highest percentage of patients with a baseline systolic blood pressure of 140 mm Hg or greater (Supplemental Table 2).

Table 2 presents the observed outcomes based on dyspnea severity at admission. Figure 2 shows the cumulative incidence of 30-day mortality and readmission based on dyspnea severity at admission. There was a graded increase in the cumulative incidence of mortality from patients with dyspnea with moderate activity to patients with dyspnea with minimal activity to patients with dyspnea at rest. We observed similar trends for the readmission outcomes.

In the unadjusted analysis, dyspnea at rest was associated with greater length of stay, 30-day mortality, all-cause and heart failure readmission, and Medicare payments and fewer days alive and out of the hospital, compared to dyspnea with moderate activity (Table 3). After multivariable adjustment, dyspnea at rest was associated with greater 30-day mortality and heart failure readmission, fewer days alive and out of the hospital at 30 days, longer length of stay, and higher Medicare payments, compared to dyspnea with moderate activity. Other independent predictors of the outcomes are presented in Supplemental Table 3.

The odds of having dyspnea at rest or with minimal activity compared with dyspnea with moderate activity were higher for patients who currently smoked and or had chronic obstructive pulmonary disease or diabetes ($p < 0.01$ for both) (Supplemental Table 4).

Discussion

In a large US HF registry, approximately 50% of patients with acute HF and dyspnea on hospital admission reported dyspnea at rest. These patients had a distinct, severe clinical profile with higher blood pressure, heart rate, and BNP level and worse renal function compared with patients with less severe dyspnea on presentation. Dyspnea at rest was independently associated with a 72% greater risk of 30-day mortality and a 26% greater risk of 30-day HF readmission, compared with dyspnea with moderate activity. Overall, dyspnea at rest was associated with fewer days alive and out of the hospital than less severe dyspnea. In addition, dyspnea at rest was associated with 14.9% higher costs than dyspnea with moderate activity.

The primary finding of this analysis is that dyspnea at rest on admission for acute HF was independently associated with worse short-term outcomes and higher costs. Dyspnea severity should be recognized for its role as a major prognostic marker in acute HF. The prognostic utility may be additive to current risk prediction models, given that the association with worse outcomes was present after robust adjustment for variables included in prior risk models.[14,15] Although dyspnea severity is rigorously documented in acute HF clinical trials,[9] quantification of baseline dyspnea is not routinely performed in current practice. Routine clinical assessment and grading of the severity of baseline dyspnea at hospital presentation may allow clinicians to target interventions to high-risk patients in order to improve outcomes and reduce costs.[8]

Our findings support and extend previous studies demonstrating associations between dyspnea and outcomes in acute HF. For example, dyspnea relief within 6 hours of study drug initiation in the Acute Study of Clinical Effectiveness of Nesiritide in Decompensated Heart Failure (ASCEND-HF) was associated with fewer events for the composite of mortality or HF hospitalization at 30 days, compared with no early dyspnea relief.[5] Early dyspnea relief was not associated with lower mortality. The PROTECT pilot study, the PROTECT trial, and the Relaxin for the Treatment of Patients With Acute Heart Failure (Pre-RELAX-AHF) study also had mixed results with regard to associations between dyspnea relief during an acute HF hospitalization and 30-day to 60-day outcomes, including mortality and composite outcomes including readmission.[16–18] Thus, dyspnea severity on presentation may provide prognostic information distinct from dyspnea relief.

Future studies are needed to clarify whether the categories of dyspnea severity in our analysis or the more granular scales used in clinical trials (eg, Likert scale, visual analog scale) have more robust associations with outcomes.[7] Dyspnea as a patient-reported outcome or health status in acute HF should receive greater attention, including robust methods of assessment as part of routine clinical practice. Previous studies explored associations between objective measures of dyspnea evaluation (eg, peak expiratory flow rate) and patient-reported measures of dyspnea by Likert scale.[19] To our knowledge, no study has demonstrated that objective measures of dyspnea at baseline adequately quantify patient-reported dyspnea severity on admission. These data in combination with our analysis support the utility of assessing patient-reported dyspnea severity on admission for acute HF.

It is notable that a specific research instrument or standardized questionnaire was not utilized for dyspnea assessment in ADHERE. However, any decrease in precision or standardization with this approach to evaluate dyspnea severity would be expected to limit, not enhance, the ability to detect any differences in clinical outcomes. While there may be greater variability with this approach, the findings may be more applicable and generalizable to clinical practice as they represent those based on dyspnea severity as measured in routine clinical practice.

The prognostic utility of dyspnea status on admission should be distinguished from the established role of New York Heart Association (NYHA) classification in determining prognosis in outpatient settings. NYHA classification is related to symptoms of exercise intolerance in patients with chronic HF.[20] Determination of NYHA class is based not only

on symptoms of dyspnea, but also fatigue, palpitations, and angina. Patients admitted with acute HF typically have NYHA class III to IV symptoms with varying contributions related to these different symptoms. Previous studies demonstrated a lack of reproducibility and validity of NYHA classification.[21]

Contemporary acute HF trials targeting dyspnea relief have entry criteria related to baseline dyspnea severity. For example, the RELAX-AHF study enrolled patients with dyspnea at rest or with minimum exertion.[8] Our analysis demonstrates that patients with dyspnea at rest represent approximately half of all patients hospitalized with acute HF with dyspnea. Thus, dyspnea at rest is fairly common in patients with acute HF, and the use of dyspnea at rest as an entry criterion is not a major factor limiting broad generalizability. Despite dyspnea at rest being relatively common on admission for HF, our analysis provides further support for the use of this criterion in clinical trials in order to enrich the study population with high-risk patients. Patients with dyspnea at rest on admission tend to be symptomatic at discharge, a profile known to be associated with worse outcomes.[22]

The study was a retrospective analysis of data from an acute HF US registry. Despite covariate adjustment, other measured and unmeasured factors may have influenced the findings. The study population was limited to patients 65 years or older enrolled in fee-for-service Medicare and admitted between 2001 and 2006, and these findings may not apply to patients with different baseline characteristics or to more recent time periods.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Highlights

- Of 48,616 patients with acute heart failure (HF) and dyspnea, 4022 (8.3%) had dyspnea with moderate activity, 19,619 (40.3%) with minimal activity, and 24,975 (51.4%) at rest.
- Patients with dyspnea with minimal activity or at rest had greater comorbidity, including renal insufficiency.
- Dyspnea severity, as assessed in clinical practice, is an independent predictor of outcomes and costs.

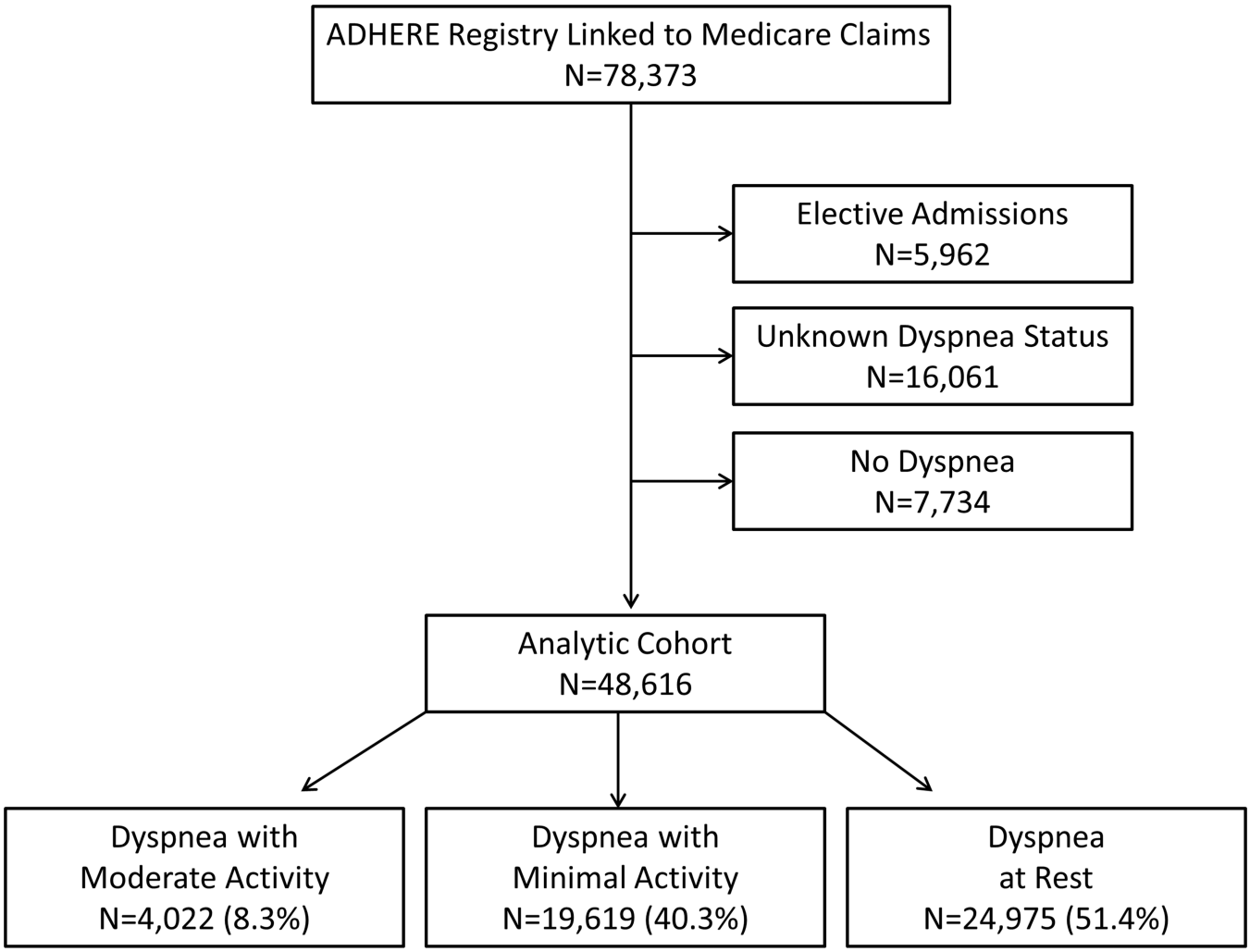
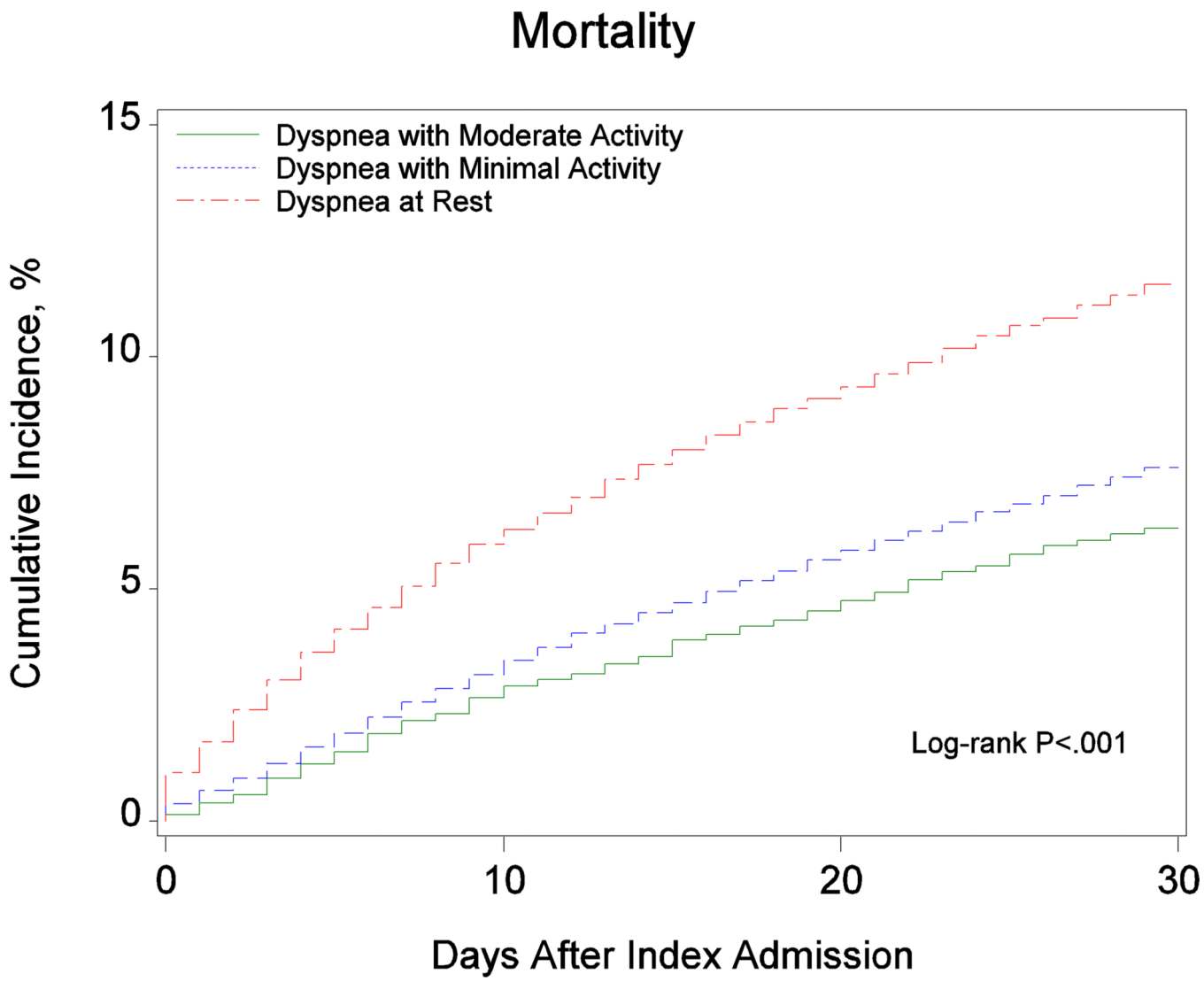
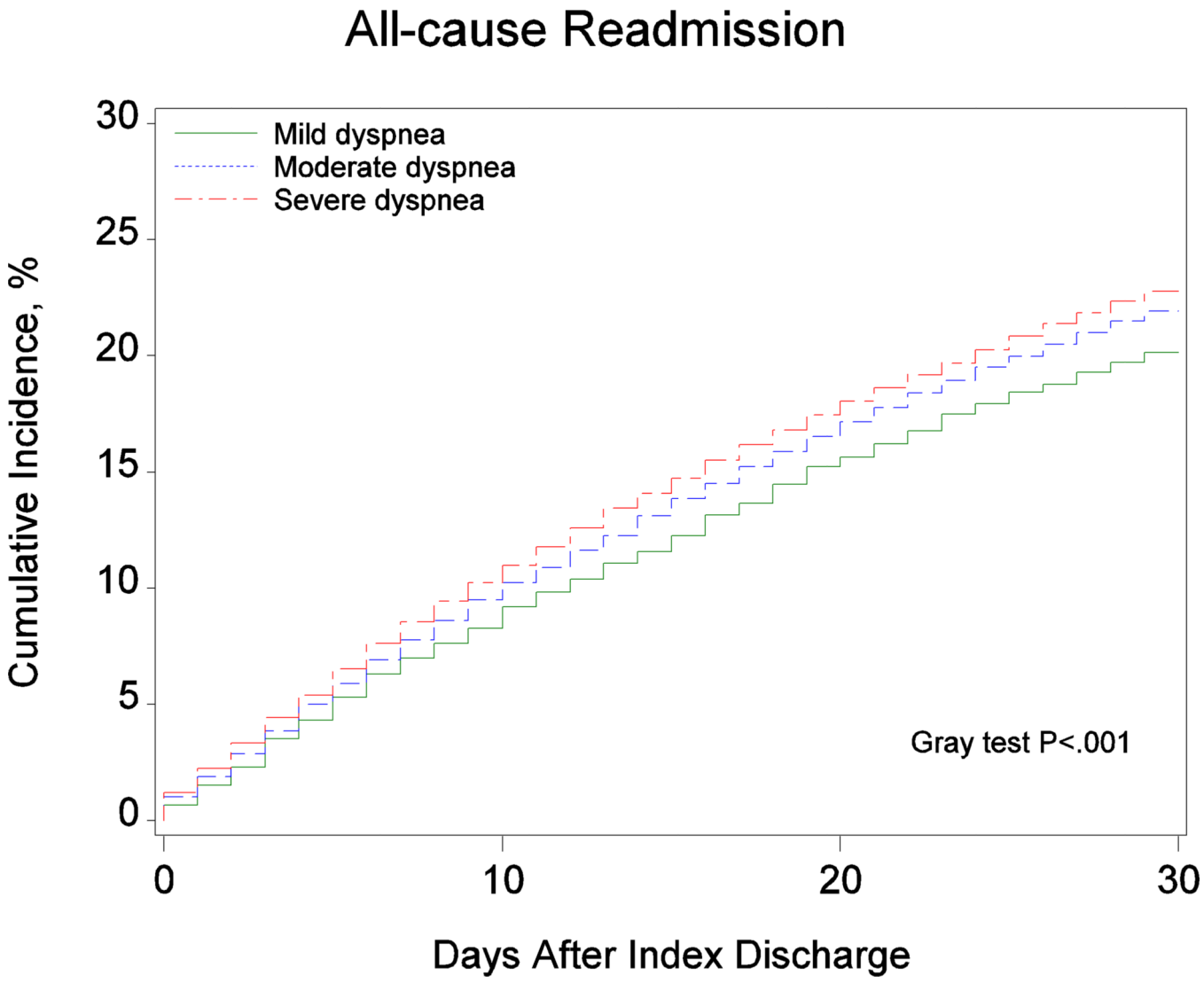


Figure 1.
Consort Diagram of the Study Population





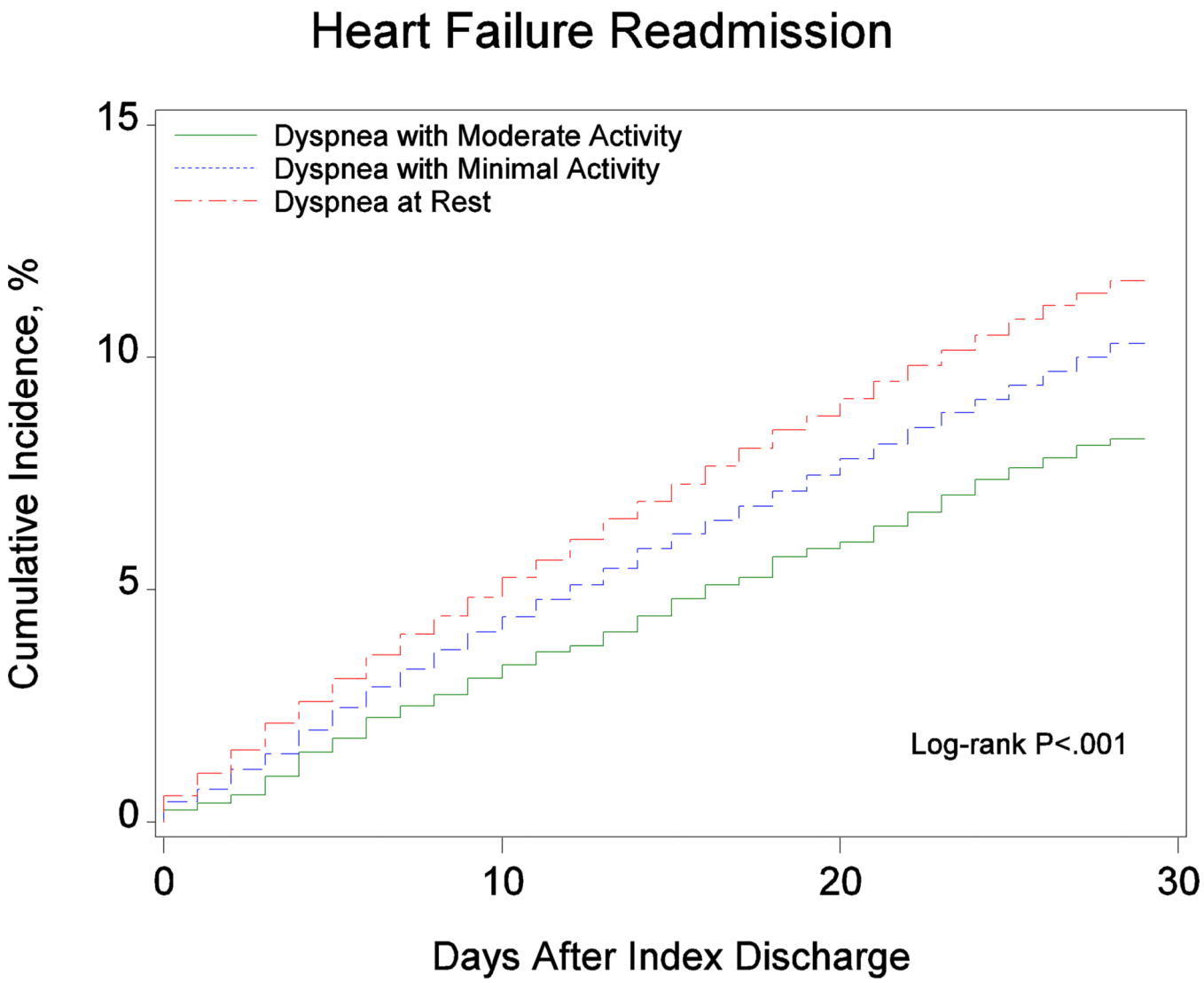


Figure 2.
Cumulative Incidence of (A) Mortality, (B) All-Cause Readmission, and (C) Heart Failure Readmission by Dyspnea Severity at Admission

Table 1

Baseline Characteristics of the Study Population by Dyspnea Severity at Admission

Characteristic	Dyspnea Severity			p Value
	Moderate Activity (n = 4022)	Minimal Activity (n = 19,619)	At Rest (n = 24,975)	
Age (years)	79.6 (73.9–85.0)	79.7 (73.9–85.1)	80.1 (74.2–85.8)	< 0.001
Men	1864 (46.3%)	8840 (45.1%)	10,636 (42.6%)	< 0.001
Race				< 0.001
Black	517 (12.9%)	2,055 (10.5%)	2745 (11.0%)	
White	3304 (82.1%)	16,181 (82.5%)	20,430 (81.8%)	
Other/unknown	201 (5.0%)	1383 (7.0%)	1800 (7.2%)	
Medical history				
Anemia	2082 (51.8%)	10,826 (55.2%)	13,315 (53.3%)	< 0.001
Atrial fibrillation	1367 (34.0%)	7264 (37.0%)	8650 (34.6%)	< 0.001
Coronary artery disease	2375 (59.1%)	12,059 (61.5%)	15,217 (60.9%)	0.02
Chronic renal insufficiency	949 (23.6%)	5623 (28.7%)	7095 (28.4%)	< 0.001
Chronic obstructive pulmonary disease	1128 (28.0%)	6095 (31.1%)	7965 (31.9%)	< 0.001
Diabetes mellitus	1522 (37.8%)	8057 (41.1%)	10,326 (41.3%)	0.001
Heart failure admission in prior 6 months	487 (12.1%)	2760 (14.1%)	3706 (14.8%)	< 0.001
Hyperlipidemia	1511 (37.6%)	7770 (39.6%)	9216 (36.9%)	< 0.001
Hypertension	2982 (74.1%)	14,777 (75.3%)	18,786 (75.2%)	0.28
Myocardial infarction	1168 (29.0%)	6220 (31.7%)	7977 (31.9%)	0.001
Peripheral vascular disease	743 (18.5%)	3804 (19.4%)	4960 (19.9%)	0.09
Stroke or transient ischemic attack	680 (16.9%)	3582 (18.3%)	4923 (19.7%)	< 0.001
Smoker				< 0.001
Never	1832 (45.5%)	8251 (42.1%)	10,950 (43.8%)	
Former	1551 (38.6%)	7627 (38.9%)	9286 (37.2%)	
Current	307 (7.6%)	1448 (7.4%)	1909 (7.6%)	
Missing	332 (8.3%)	2293 (11.7%)	2830 (11.3%)	
Devices				
Cardiac resynchronization therapy	72 (1.8%)	365 (1.9%)	377 (1.5%)	0.01
Implantable cardioverter-defibrillator	208 (5.2%)	1143 (5.8%)	1326 (5.3%)	0.04
Pacemaker	738 (18.3%)	3899 (19.9%)	4613 (18.5%)	< 0.001
Initial evaluation				
Ejection fraction				< 0.001
≥ 40%	2007 (49.9%)	9438 (48.1%)	11,320 (45.3%)	
< 40%	1417 (35.2%)	7298 (37.2%)	9318 (37.3%)	
Missing	598 (14.9%)	2883 (14.7%)	4337 (17.4%)	
Fatigue	1240 (30.8%)	7475 (38.1%)	8758 (35.1%)	< 0.001
Pulmonary edema	3385 (84.2%)	17,224 (87.8%)	22,931 (91.8%)	< 0.001
Rales	2632 (65.4%)	13,805 (70.4%)	19,266 (77.1%)	< 0.001
Initial vital signs				

Characteristic	Dyspnea Severity			p Value
	Moderate Activity (n = 4022)	Minimal Activity (n = 19,619)	At Rest (n = 24,975)	
BNP level (pg/mL)	739 (397–1307)	839 (437–1440)	924 (470–1540)	< 0.001
Missing	1705 (42.4%)	8406 (42.8%)	10,485 (42.0%)	
Pulse (bpm)	82.0 (70.0–96.0)	82.0 (70.0–98.0)	86.0 (73.0–103)	< 0.001
Systolic blood pressure (mm Hg)	143 (124–165)	142 (122–163)	145 (124–168)	< 0.001
Initial laboratory test results				
eGFR (mL/min/1.73 m^2)	51.2 (36.0–67.3)	48.2 (33.7–63.7)	47.7 (33.3–63.6)	< 0.001
Hemoglobin (g/dL)	12.2 (10.9–13.5)	12.1 (10.7–13.4)	12.1 (10.8–13.5)	< 0.001
Serum creatinine (mg/dL)	1.3 (1.0–1.7)	1.3 (1.0–1.8)	1.3 (1.0–1.8)	< 0.001
Serum sodium (mEq/L)	139 (136–141)	139 (136–141)	139 (136–141)	0.04
Medication at discharge†				
ACE inhibitor or ARB	2511 (63.8%)	12,080 (63.6%)	14,430 (61.3%)	< 0.001
Aspirin	1972 (50.1%)	9222 (48.5%)	11,297 (48.0%)	0.05
β-Blocker	2329 (59.2%)	11,476 (60.4%)	14,057 (59.8%)	0.26
Clopidogrel	510 (13.0%)	2660 (14.0%)	3366 (14.3%)	0.08
Diuretic	2959 (75.2%)	14,887 (78.3%)	17,404 (74.0%)	< 0.001
Lipid-lowering agent	1482 (37.7%)	6979 (36.7%)	8233 (35.0%)	< 0.001
Warfarin	1126 (28.6%)	5671 (29.8%)	6286 (26.7%)	< 0.001
Index hospitalization year				< 0.001
2001	86 (2.1%)	549 (2.8%)	743 (3.0%)	
2002	1141 (28.4%)	5605 (28.6%)	7561 (30.3%)	
2003	1353 (33.6%)	6607 (33.7%)	7914 (31.7%)	
2004	980 (24.4%)	5055 (25.8%)	5917 (23.7%)	
2005	420 (10.4%)	1646 (8.4%)	2597 (10.4%)	
2006	42 (1.0%)	157 (0.8%)	243 (1.0%)	

Definitions: Anemia, hypertension, and hyperlipidemia were based on documentation of these clinical diagnoses in the medical history.

Abbreviations: ACE, angiotensin-converting enzyme; ARB, angiotensin II receptor blocker; BNP, B-type natriuretic peptide; eGFR, estimated glomerular filtration rate.

*Within the previous 6 months.

†Data are presented only for patients discharged alive, including 3933 patients with dyspnea with moderate activity, 19,006 patients with dyspnea with minimal activity, and 23,524 patients with dyspnea at rest.

Table 2

Observed Outcomes by Dyspnea Severity at Admission

Outcomes	Dyspnea With Moderate Activity (n = 4022)	Dyspnea With Minimal Activity (n = 19,619)	Dyspnea at Rest (n = 24,975)	p Value
Length of stay, median (IQR) (days)	4.0 (3.0–6.0)	4.0 (3.0–7.0)	4.0 (3.0–7.0)	< 0.001
In-hospital mortality	89 (2.2%)	613 (3.1%)	1451 (5.8%)	< 0.001
Discharged alive	3731 (92.8%)	18,149 (92.5)	22,143 (88.7%)	
Clinical status at discharge				< 0.001
Asymptomatic	2097 (56.2%)	9074 (50.0%)	10,856 (49.1%)	
Still symptomatic	1390 (37.3%)	7579 (41.8%)	9371 (42.4%)	
Other/unknown	242 (6.5%)	1479 (8.2%)	1895 (8.6%)	
Discharged alive, not censored at 30 days	3729 (92.7%)	18,132 (92.4%)	22,122 (88.6%)	
Days alive and out of hospital at 30 days after discharge (days)	30.0 (30.0–30.0)	30.0 (29.0–30.0)	30.0 (28.0–30.0)	< 0.001
Mortality at 30 days	254 (6.3%)	1493 (7.6%)	2888 (11.6%)	< 0.001
All-cause readmission at 30 days after discharge†	751 (20.1%)	3974 (21.9%)	5037 (22.8%)	< 0.001
Heart failure readmission at 30 days†	252 (7.2%)	1527 (9.0%)	1964 (9.4%)	< 0.001
Medicare payments at 30 days after discharge ($)‡	520 (253–2421)	569 (264–3693)	572 (268–4621)	< 0.001

Abbreviations: IQR, interquartile range.

*Presented as the number of patients (cumulative incidence per 100 patients at risk) who died within 30 days after admission to the index hospitalization.

†Presented as the number of patients (cumulative incidence per 100 patients at risk) who were readmitted within 30 days after discharge from the index hospitalization.

‡Presented in 2010 US dollars.

Table 3

Unadjusted and Adjusted Associations Between Dyspnea Severity at Admission and Outcomes

Outcome	Unadjusted Association		Adjusted Association[§]	
	HR (99% CI)	p Value	HR (99% CI)	p Value
Mortality within 30 days after admission[*]				
Dyspnea with minimal activity vs moderate activity	1.21 (1.02 to 1.44)	0.004	1.11 (0.93 to 1.32)	0.14
Dyspnea at rest vs with moderate activity	1.89 (1.60 to 2.24)	< 0.001	1.72 (1.45 to 2.03)	< 0.001
Dyspnea at rest vs with minimal activity	1.56 (1.42 to 1.72)	< 0.001	1.55 (1.41 to 1.71)	< 0.001
All-cause readmission within 30 days after discharge[†]				
Dyspnea with minimal activity vs moderate activity	1.10 (1.00 to 1.23)	0.01	1.06 (0.95 to 1.18)	0.18
Dyspnea at rest vs with moderate activity	1.17 (1.04 to 1.30)	< 0.001	1.12 (1.00 to 1.25)	0.01
Dyspnea at rest vs with minimal activity	1.05 (0.99 to 1.12)	0.02	1.06 (1.00 to 1.12)	0.01
Heart failure readmission within 30 days after discharge[†]				
Dyspnea with minimal activity vs moderate activity	1.26 (1.05 to 1.51)	< 0.001	1.19 (0.99 to 1.42)	0.01
Dyspnea at rest vs with moderate activity	1.35 (1.14 to 1.59)	< 0.001	1.26 (1.07 to 1.49)	< 0.001
Dyspnea at rest vs with minimal activity	1.07 (0.98 to 1.16)	0.05	1.06 (0.98 to 1.16)	0.07
Days alive and out of hospital at 30 days after discharge[‡]				
Dyspnea with minimal activity vs moderate activity	−0.281 (−0.553 to −0.009)	0.008	−0.129 (−0.396 to 0.139)	0.21
Dyspnea at rest vs with moderate activity	−0.656 (−0.924 to −0.388)	< 0.001	−0.492 (−0.757 to −0.227)	< 0.001
Dyspnea at rest vs with minimal activity	−0.375 (−0.528 to −0.222)	< 0.001	−0.363 (−0.515 to −0.211)	< 0.001
Length of stay for the index hospitalization[*]				
Dyspnea with minimal activity vs moderate activity	0.415 (0.189 to 0.642)	< 0.001	0.251 (0.029 to 0.474)	0.004
Dyspnea at rest vs with moderate activity	0.677 (0.454 to 0.900)	< 0.001	0.515 (0.295 to 0.736)	< 0.001
Dyspnea at rest vs with minimal activity	0.262 (0.135 to 0.389)	< 0.001	0.264 (0.138 to 0.390)	< 0.001
Medicare payments at 30 days after discharge[‡]				
Dyspnea with minimal activity vs moderate activity	1.105 (0.981 to 1.246)	0.03	1.072 (0.955 to 1.203)	0.12
Dyspnea at rest vs with moderate activity	1.176 (1.046 to 1.323)	< 0.001	1.149 (1.025 to 1.288)	0.002
Dyspnea at rest vs with minimal activity	1.064 (0.997 to 1.134)	0.01	1.071 (1.006 to 1.141)	0.005

Abbreviations: CI, confidence interval; HR, hazard ratio.

[*] Among all patients in the study population.

[†] Among patients discharged alive.

[‡] Among patients discharged alive, not censored, at 30 days after discharge.

[§] Adjusted for demographics (age, gender, race), medical history (anemia, atrial fibrillation, coronary artery disease, chronic renal insufficiency, COPD, diabetes mellitus, HF, hyperlipidemia, hypertension, prior myocardial infarction, peripheral vascular disease, prior stroke/TIA, smoking status, pacemaker type, implantable cardioverter defibrillator), initial evaluation/vital signs/lab results (fatigue, rales, pulmonary edema, ejection fraction, pulse, systolic blood pressure, serum sodium, hemoglobin, serum creatinine), medications (ACE inhibitor or ARB, aspirin, beta blocker, diuretic, clopidogrel, lipid-lowering, warfarin), and year of index hospitalization. Post-discharge models include medication information from discharge.