Geriatric Heart Failure, Depression, and Nursing Home Admission: An Observational Study Using Propensity Score Analysis

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Objective: *Heart failure (HF) and depression are both common in older adults, and the presence of depression is known to worsen HF outcomes. For community-dwelling older adults, admission to a nursing home (NH) is associated with loss of independent living and poor outcomes. The objective of this study was to examine the effect of depression on NH admission for older adults with HF.* **Methods:** *Using the 2001–2003 National Hospital Discharge Survey datasets, the authors identified all community-dwelling older adults who were discharged alive with a primary discharge diagnosis of HF. The authors then identified those with a secondary diagnosis of depression. Using a multivariable logistic regression model, the authors then determined probability or propensity to have depression for each patient. The authors used propensity scores for depression to match all 680 depressed patients with 2,040 nondepressed patients. Finally, the authors estimated the association between depression and NH admission using bivariate and multivariable logistic regression analyses.* **Results:** *Patients had a mean (± standard deviation) age of 79 (± 8) years, 72% were women, and 9% were blacks. Compared with 17% nondepressed patients, 25% depressed patients were discharged to a NH. Depression was associated with 50% increased risk of NH admission (unadjusted relative risk [RR]: 1.50; 95% confidence interval [CI]: 1.28–1.74). The association became somewhat stronger after multivariable adjustment for various demographic and care covariates (adjusted RR: 1.60; 95% CI: 1.35–1.68).* **Conclusion:** *In ambulatory older adults hospitalized with HF, a secondary diagnosis of depression was associated with a significant increased risk of NH admission.* (Am J Geriatr Psychiatry 2006; 14:867–875)

Key Words: Heart failure, older adults, depression, nursing home, propensity score

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Heart failure (HF) is highly prevalent among older adults and is associated with morbidity and mortality. There are approximately five million Americans with HF and an estimated 500,000 patients are newly diagnosed with this condition every year.[1,2] Most of these patients are 65 years and older. HF is the most common hospital discharge diagnosis among this age group,[3] and it is responsible for around 40,000 deaths annually and associated with over an additional 200,000 deaths.[1] With the aging of the U.S. population, it is expected that the number of older adults with HF will increase considerably.[4–7]

Depression in older adults is common and associated with poor outcomes.[8,9] Roughly 20% of the U.S. population 65 years and older have depression compared with 7% in younger adults.[10,11] The prevalence of depression is also high among patients with cardiovascular disorders[12–14] and depression is also common in patients with HF. Several studies have documented that the presence of depression is associated with poor outcomes.[15–19] However, most of these studies were restricted to younger patients with systolic HF seen in academic medical centers.[20]

Age is negatively associated with quality of HF care,[21–23] and HF care in nursing homes (NHs) is particularly poor.[24,25] Hospitalization is often an adverse event for older adults with HF and is associated with high risk of in-hospital and postdischarge death as well as rehospitalization.[1,2,26] Hospitalization is also associated with admission to a NH and subsequent loss of independent community living.[20,27,28] Among community-dwelling older adults hospitalized with HF, age, length of stay, and presence of diabetes were strong predictors of NH admission after hospital discharge.[29] To the best of our knowledge, the impact of depression on admission to NH for community-dwelling older adults hospitalized with HF has not been previously reported. The objective of our study was to determine if among ambulatory older adults hospitalized with HF, a secondary diagnosis of depression was associated with increased risk of postdischarge NH admission.

METHODS

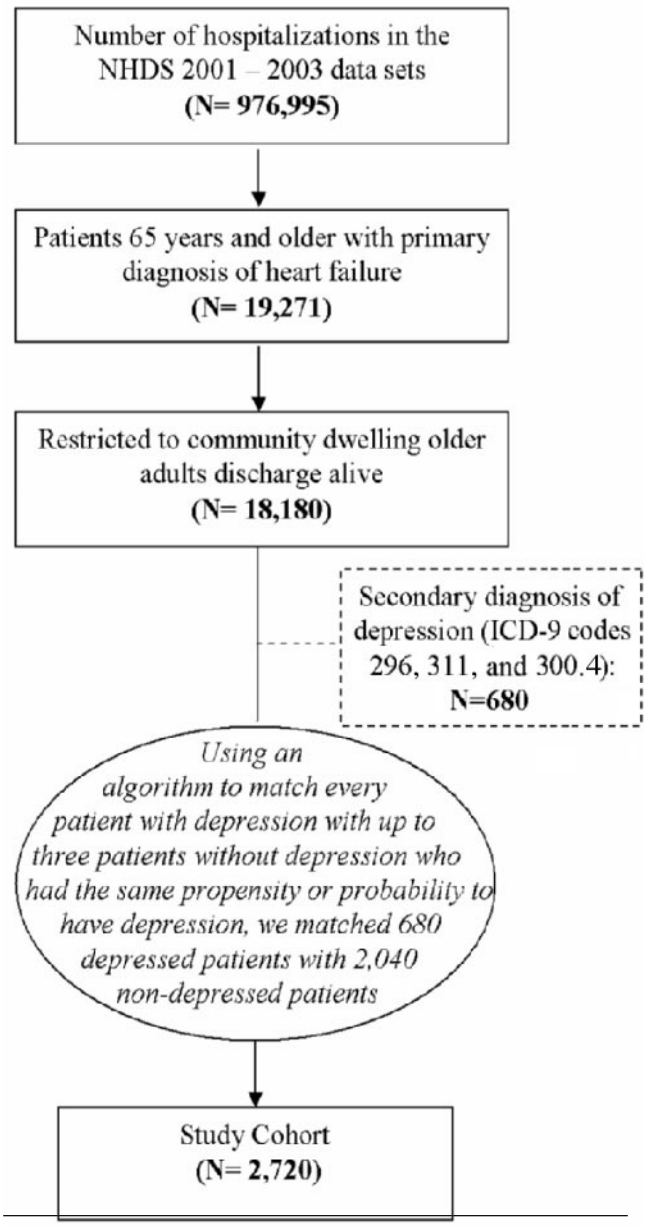
Data Source and Patients

We conducted a retrospective study of the 2001–2003 National Hospital Discharge Survey (NHDS) datasets available at ftp://ftp.cdc.gov/pub/Health_Statistics/NCHS/Datasets/NHDS. The NHDS is a continuous sample of hospital discharge records conducted annually by the National Center for Health Statistics (NCHS).[30] NHDS data are abstracted from medical records of patients discharged from a sample of nonfederal short-stay hospitals in all 50 states and the District of Columbia. Only hospitals having six or more beds and those in which the average length of stay for all patients is less than 30 days are included. Medical diagnoses and surgical procedures are coded according to the International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM). The hospital sample is periodically updated to reflect changes in eligibility. The NHDS adopts a complex, stratified, multistage probability design to ensure a representative national sampling. The process for the selection of study sample for our analysis is displayed in Figure 1. Variables in the NHDS dataset include data on age, gender, race, marital status, primary discharge diagnosis, up to six secondary discharge diagnoses, hospital bed size, geographic location and ownership, type of hospital admission, primary and secondary source of payment, discharge month, and length of stay. For the purpose of this analysis, we excluded patients who were younger than 65 years, those admitted from NHs at the time of hospital admission, and those who died during their hospital stay.

Primary Diagnosis of Heart Failure

The 2001–2003 NHDS datasets included 976,995 sampled hospital discharges. The datasets are based on hospital discharge records and not on unique individual patients. It is possible that patients with multiple hospitalizations were captured more than once. However, such duplications are likely to be random across patients with and without depression. For convenience of description, we treated each discharge as representing unique patients. We identified patients with a primary discharge diagnosis of HF by the ICD-9-CM code 428. Of the 976,995 patients in the 2001−2003 NHDS datasets, 19,271 were 65 years of age and older and discharged with a primary discharge diagnosis of HF (Figure 1). Of these, 19,058 were living in the community before

FIGURE 1. Algorithm for Selecting the Study Cohort



hospitalization and 18,180 were discharged alive from the hospital (Figure 1).

Secondary Diagnosis of Depression

We used the ICD-9-CM codes 296, 311, and 300.4 (neurotic depression) to ascertain patients with a secondary diagnosis of depression, and a total of 680 patients were thus identified.

Other Secondary Diagnoses

We identified secondary diagnoses coronary artery disease (ICD-9-CM codes 410–414), dysrhythmias (ICD-9-CM code 427), hypertension (ICD-9-CM codes 401–405), diabetes mellitus (ICD-9-CM code 250), hypothyroidism (ICD-9-CM code 244), chronic obstructive pulmonary disease [COPD] (ICD-9-CM codes 491–492 and 496), pneumonia (ICD-9-CM codes 480–487), syncope (ICD-9-CM code 780.2), acute renal failure (ICD-9-CM code 584), iron deficiency anemia (ICD-9-CM code 280), urinary incontinence (ICD-9-CM code 788), urinary tract infection (ICD-9-CM code 599), and dementia (ICD-9-CM codes 094, 290, 291, 292, 294, and 331) from the list of secondary diagnoses in the dataset.

Primary Outcome

The primary outcome of interest was NH admission at the time of hospital discharge. This was identified from the "discharge status" variable in the dataset.

Statistical Analysis

We began by analyzing the baseline characteristics of patients with and without depression in the original dataset (N = 18,180) and tested statistical significance using chi-squared test and Student t test as appropriate. To balance baseline covariates between patients with and without depression, we used propensity scores for depression to match patients with and without depression. Matching by propensity score, which is a single composite score based on all available covariates, is considered superior to matching by individual covariates such as age, sex, race, and so on, which would result in a significant reduction in sample size.

The propensity score is the conditional probability of receiving a particular exposure or treatment (for example, tobacco or aspirin use) given a vector of covariates.[31,32] This probability is usually estimated using a nonparsimonious multivariable logistic regression model with the exposure of interest (in our case, depression) as the dependent variable. Assignment of treatment in observational studies is not random and generally determined by various patient characteristics. This bias often makes it difficult to interpret the findings of observational studies, which can be addressed by use of propensity score method.[33,34] When used in observational studies, it is considered equivalent to a retrospective randomization. The key distinction from randomization is that propensity score matching cannot account for unmeasured covariates. In the study of the effect of comorbid conditions (e.g., depression) on outcomes (NH admission) in a group of patients (HF), it is often difficult to sort out if the outcomes observed were the result of the comorbid condition studied, other comorbid conditions (diabetes, dementia, and so on), or patient characteristics (age, sex, and so on). Because matching by propensity score balances all measured covariates at study baseline, it is easier to attribute any observed difference in outcomes to the comorbidity studied. Unlike in study of therapies, for which randomization is the gold standard, patients cannot be randomized to have or develop comorbid conditions. As such, the propensity score method is a rather unique tool to control for selection bias in the study of comorbidities in older adults.

In the multivariable logistic regression model to calculate propensity scores, we used secondary diagnosis of depression as the dependent variable and all available baseline variables were used as covariates. The model included the covariates presented in Table 1. The months of July and August were included as a result of their being the first 2 months of residency training. We used the predicted probability of depression (the propensity score) to match patients with a secondary diagnosis of depression to those with similar propensity scores for depression but who did not have a secondary diagnosis of depression. There were no clinically significant interactions between the covariates.

We used a SPSS macro to randomly match patients.[35] For the purpose of matching, we first multiplied the propensity scores (e.g., 0.1252072) by 100,000 (e.g., 12520.72) and then rounded the resulting number to the nearest value divisible by 0.25. For example, if a patient with depression had a five-digit propensity score of 12520.72 and a patient without depression had a five-digit propensity score of 12520.81, they were both rounded to become 12520.75 and matched. We matched each patient with depression with up to three patients without depression who had the same five-digit propensity score. Matched patients with no depression were then removed from the file and this process was repeated on the remaining file but this time multiplying the propensity scores by 10,000 instead of 100,000. This was done three more times multiplying the propensity scores, respectively, by 1,000, 100, and 10. This way, all 680 patients with depression were matched with 2,040 patients without depression.

We compared the baseline characteristics between the patients with and without depression in post-match cohort and estimated absolute standardized differences on key covariates.[36] Bivariate and multivariable logistic regression analyses were done to obtain odds ratios and 95% confidence intervals for NH admission for patients who were depressed compared with those not depressed. Covariates in the multivariable model were the same as those used in the model for propensity score. We also examined the effect of other covariates on NH admission using the same model (except that age and length of stay were used as categorical variables). Odds ratios and their 95% confidence intervals were converted into relative risks and their 95% confidence intervals.[37] We then examined the effects of depression on subgroups of patients based on age, sex, race, marital status, coronary artery disease, diabetes, dementia, and hypothyroidism. All tests were based on a two-sided p value and p values of <0.05 were considered significant. All analyses were done using SPSS 13.2 for Windows.[38]

RESULTS

Patient Characteristics

In the propensity score-matched cohort ($N = 2{,}720$), patients had a mean ($\pm$ standard deviation) age of 78.9 ($\pm$ 7.8) years, 1,952 (71.8% were women, and 240 (8.8%) were black. Table 1 compares baseline characteristics between patients with and without a secondary diagnosis of depression before and after propensity score matching. Before matching, patients who were depressed were more likely to be women and have hypothyroidism, dementia, and hypertension. Patients who were depressed were also less likely to be black and to have coronary artery disease, cardiac dysrhythmias, diabetes, and acute renal failure. After matching, there was no significant dif-

TABLE 1. Baseline Patient Characteristics by the Depression Before and After Matching by Propensity Scores

	Prematch			Postmatch		
	No Depression (N = 17,500) (96.3%)	Depression (N = 680) (3.2%)	p	No Depression (N = 2,040) (75.0%)	Depression (N = 680) (25.0%)	p
Age (years), mean (± standard deviation)	79.2 (± 7.8)	78.9 (± 7.6)	0.288	78.9 (± 7.9)	78.9 (± 7.6)	0.891
Female	10,090 (57.7%)	480 (70.6%)	<0.0001	1,472 (72.2%)	480 (70.6%)	0.431
Black	2,230 (12.7%)	59 (8.7%)	0.002	181 (8.9%)	59 (8.7%)	0.876
Married	2,520 (14.4%)	93 (13.7%)	0.598	261 (12.8%)	93 (13.7%)	0.554
Comorbid conditions						
Coronary artery disease	7,942 (45.4%)	251 (36.9%)	<0.0001	762 (37.4%)	251 (36.9%)	0.837
Cardiac dysrhythmia	7,013 (40.1%)	209 (30.7%)	<0.0001	641 (31.4%)	209 (30.7%)	0.738
Hypertension	8,592 (49.1%)	370 (54.4%)	0.007	1,120 (54.9%)	370 (54.4%)	0.824
Diabetes mellitus	5,619 (32.1%)	191 (28.1%)	0.027	563 (27.6%)	191 (28.1%)	0.805
Hypothyroidism	1,414 (8.1%)	99 (14.6%)	<0.0001	284 (13.9%)	99 (14.6%)	0.679
Chronic obstructive pulmonary disease	5,354 (30.6%)	205 (30.1%)	0.804	568 (27.8%)	205 (30.1%)	0.249
Pneumonia	1,010 (5.8%)	29 (4.3%)	0.097	102 (5.0%)	29 (4.3%)	0.438
Syncope	311 (1.8%)	18 (2.6%)	0.095	43 (2.1%)	18 (2.6%)	0.411
Acute renal failure	822 (4.7%)	16 (2.4%)	0.004	48 (2.4%)	16 (2.4%)	>0.999
Iron-deficient anemia	576 (3.3%)	11 (1.6%)	0.015	31 (1.5%)	11 (1.6%)	0.857
Urinary incontinence	322 (1.8%)	13 (1.9%)	0.891	35 (1.7%)	13 (1.9%)	0.737
Urinary tract infection	1,703 (9.7%)	47 (6.9%)	0.014	132 (6.5%)	47 (6.9%)	0.688
Dementia	998 (5.7%)	75 (11.4%)	<0.0001	220 (10.8%)	75 (11.0%)	0.859
Hospitals by bed size						
Small (6–199 beds)	7,224 (41.3%)	301 (44.3%)	0.141	910 (44.6%)	301 (44.5%)	0.984
Medium (200–499 beds)	8,416 (48.1%)	320 (47.1%)		952 (46.7%)	320 (47.1%)	
Large (≥500 beds)	1,860 (10.6%)	59 (8.7%)		178 (8.7%)	59 (8.7%)	
Hospitals by geographic region						
Northeast	4,299 (24.6%)	184 (27.1%)	0.354	551 (27.0%)	184 (27.1%)	0.968
Midwest	6,224 (35.6%)	245 (36.0%)		716 (35.1%)	245 (36.0%)	
South	5,268 (30.1%)	187 (27.5%)		577 (28.3%)	187 (27.5%)	
West	1,709 (9.8%)	64 (9.4%)		196 (9.6%)	64 (9.4%)	
Hospitals by ownership						
For profit	15,227 (87.0%)	587 (86.3%)	0.601	1,766 (86.6%)	587 (86.3%)	0.871
Nonprofit	2,273 (13.0%)	93 (13.7%)		274 (13.4%)	93 (13.7%)	
Type of admission						
Emergency	9,216 (52.7%)	379 (55.7%)	0.115	1,164 (57.1%)	379 (55.7%)	0.546
Others	8,284 (47.3%)	301 (44.3%)		876 (42.9%)	301 (44.3%)	
Primary source of payment						
Medicare	15,630 (89.3%)	622 (91.5%)	0.073	1,884 (92.4%)	622 (91.5%)	0.459
Secondary sources of payment						
Medicaid	1,654 (9.5%)	66 (9.7%)	0.824	193 (9.5%)	66 (9.7%)	0.850
Private	7,418 (42.4%)	282 (41.5%)	0.637	835 (40.9%)	282 (41.5%)	0.805
Length of stay						
≤4 days	9,530 (54.5%)	390 (57.4%)	0.137	1,191 (58.4%)	390 (57.4%)	0.637
>4 days	7,970 (45.5%)	290 (42.6%)		849 (41.6%)	290 (42.6%)	
Discharge in July or August	2,726 (15.6%)	129 (19.0%)	0.017	378 (18.5%)	129 (18.6%)	0.798

ference in terms of any baseline covariates between the two groups (Table 1).

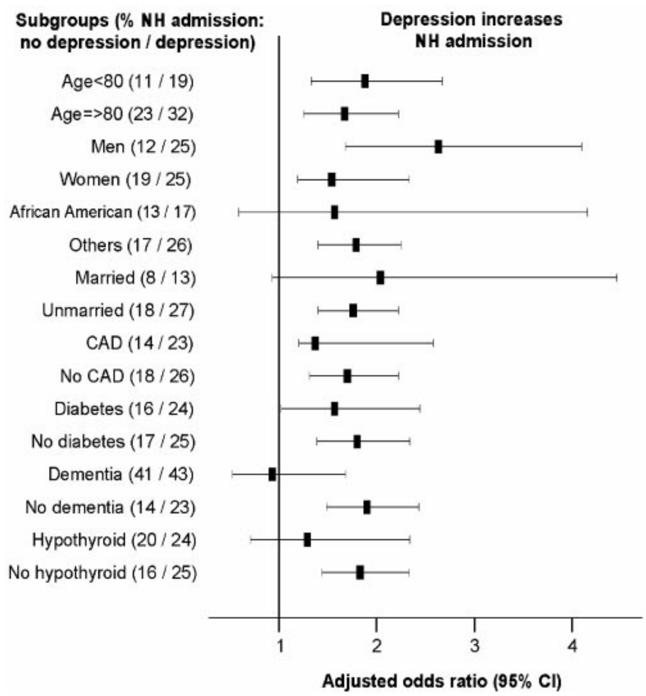
Depression and Nursing Home Admission

Table 2 demonstrates that compared with 17% (340 of 2,040) patients without depression, 25% (170 of 680) of those with a secondary diagnosis of depression were admitted to a NH at the time of hospital discharge (an 8% increase in absolute risk, p <0.0001). Ambulatory older adults hospitalized with HF, who also had a secondary diagnosis of depression, had 67% higher odds of NH admission compared with those without depression. Depression was associated with a 50% higher risk of NH admission after hospital discharge (relative risk: 1.50; 95% confidence interval [CI]: 1.28−1.74). When adjusted for various demographic, clinical and care-related covariates, the association became stronger (adjusted relative risk: 1.60; 95% CI: 1.35−1.68). Additional adjustment for propensity score did not alter this association (Table 2).

Results of the Subgroup Analysis

Figure 2 displays that the associations between depression and NH admission were observed in almost all subgroups of patients. The association between a secondary diagnosis of depression and subsequent admission to a NH was more pronounced in men than in women (an absolute risk difference of 7%; p for interaction = 0.034). The interaction between depression and sex persisted after adjustment for other covariates (adjusted p for interaction = 0.039). The effect of depression was also more pronounced in patients without dementia (an absolute risk increase of 7%; p for interaction = 0.053). However, the differential effect of depression did not persist after multivariable adjustment (adjusted p for interaction = 0.151). Of note, patients with a secondary diagnosis of dementia had the highest rate for NH admission after hospital discharge (43% and 41%, respectively, for patients with and without a secondary diagnosis of depression).

FIGURE 2. Adjusted Odds Ratio (95% Confidence Interval) for Nursing Home Admission in Subgroups of Patients with Heart Failure



These odds ratios were adjusted for the same covariates as in Table 2; adjusted p for interaction between depression and gender = 0.039; CAD: coronary artery disease.

Other Predictors of Nursing Home Admission

Table 3 displays that age 80 years and older, female sex, and presence of a secondary diagnosis of diabetes, pneumonia, COPD, acute renal failure, urinary tract infection, hypothyroidism, and dementia were independently associated with higher odds of NH admission. In addition, length of hospital stay 4 or more days, having Medicaid insurance, and admission to not-for-profit hospitals were associated with higher odds of NH admission. Patients who

TABLE 2. Unadjusted and Adjusted Odds Ratios (ORs), Relative Risk (RR), and 95% Confidence Intervals (CIs) for Admission Into a Nursing Home Among Propensity Score-Matched Older Adults Discharged With a Primary Discharge Diagnosis of Heart Failure by Depression

	No Depression	Depression
Total number	2,040	680
Number admitted to a nursing home	340	170
Absolute risk	16.7% (340/2,040)	25.0% (170/6,808)
Absolute risk difference	Reference	8.3% (Pearson chi-square p <0.0001)
OR, unadjusted (95% CI); value	1	1.67 (1.35–2.05); p <0.0001
RR,[a] unadjusted (95% CI)	1	1.50 (1.28–1.74)
OR, adjusted for covariates[b] (95% CI)	1	1.82 (1.45–2.27); p <0.0001
RR,[a] adjusted for covariates[b] (95% CI)	1	1.60 (1.35–1.68)
OR, adjusted for covariates[b] and propensity scores (95% CI)	1	1.82 (1.45–2.27); p <0.0001
RR,[a] adjusted for covariates[b] and propensity scores (95% CI)	1	1.60 (1.35–1.68)

[a]Absolute RR calculated from OR using formula proposed by Zhang et al.[37]
[b]Covariates used are the same as used in the propensity score model.

TABLE 3. Covariates Significantly Associated With Nursing Home Admission[a]

	Unadjusted Odds Ratio (95% Confidence Interval)	p Value	Adjusted Odds Ratio (95% Confidence Interval)	p Value
Age ≥80 years	2.36 (1.93–2.88)	<0.0001	2.10 (1.68–2.61)	<0.0001
Female	1.44 (1.15–1.81)	0.002	1.28 (1.00–1.64)	0.053
Black	0.70 (0.48–1.01)	0.058	0.95 (0.63–1.43)	0.798
Married	0.44 (0.30–0.63)	<0.0001	0.55 (0.38–0.82)	0.003
Diabetes	0.94 (0.75–1.16)	0.555	1.28 (1.01–1.63)	0.043
Pneumonia	1.76 (1.19–2.61)	0.005	1.53 (1.01–2.33)	0.047
Chronic obstructive pulmonary disease	1.15 (0.93–1.42)	0.189	1.34 (1.07–1.68)	0.012
Acute renal failure	1.86 (1.08–3.21)	0.025	1.95 (1.09–3.50)	0.025
Urinary tract infection	1.92 (1.37–2.69)	<0.0001	1.48 (1.03–2.12)	0.034
Hypothyroidism	1.22 (0.93–1.59)	0.151	1.40 (1.05–1.86)	0.022
Dementia	3.76 (2.92–4.86)	<0.0001	3.53 (2.68–4.65)	<0.0001
Hospitals in the south	0.60 (0.48–0.76)	<0.0001	0.69 (0.53–0.0.89)	0.004
Hospitals with 200–499 beds	0.73 (0.60–0.88)	0.001	0.71 (0.58–0.88)	0.002
Not-for-profit hospital	1.67 (1.21–2.30)	0.002	1.49 (1.05–2.11)	0.027
Medicaid insurance	1.66 (1.24–2.23)	0.001	1.70 (1.23–2.35)	0.001
Length of stay ≥4 days	1.81 (1.49–2.19)	<0.0001	1.83 (1.49–2.26)	<0.001

[a]Covariates used are the same as used in Table 2.

were married, hospitalized in the south, and those admitted to hospitals with bed size 200–499 had lower odds of admission to NH.

DISCUSSION

The results of our analysis demonstrate the presence of a secondary diagnosis of depression was associated with a significant increased risk for NH admission among older adults hospitalized with acute HF who were community dwelling before hospitalization. These findings are important because depression is a relatively common comorbidity in patients with HF[39–41] and is often a treatable condition, although it is often underdiagnosed and undertreated.

The specific physiological mechanisms by which depression adversely affected hospital discharge disposition for ambulatory older adults hospitalized with HF is unknown. Mental stress,[42] exaggerated platelet reactivity,[43] and decreased heart rate variability secondary to autonomic dysfunction[44] have been associated with increased depression-related mortality and morbidity among patients with ischemic heart disease. Depression has also been associated with various immunologic and hematologic abnormalities and poor self-reported health.[45,46] Finally, adverse outcomes among patients with HF with depression is believed to be the result of depression-related activation of various neurohormones, arrhythmias, poor quality of life, lack of motivation, and decline in physical and social function.[8,19,47,48]

To the best of our knowledge, this is the first study that examined the effect of a secondary diagnosis of depression in patients with heart failure on NH admission after hospital discharge. Previous studies of depression and HF outcomes primarily focused on outcomes such as mortality, hospitalization, and quality of life.[15,49,50] NH placement is a negative life event for community-dwelling older adults.[51] We noted that the presence of a secondary diagnosis of depression was the fourth strongest predictor of NH admission in patients with HF. Only those with dementia, age 80 years and older, and acute renal failure had higher odds of NH admission (Table 3). We also noted that patients hospitalized in the south, in government and proprietary hospitals, and in those with 200–499 beds were less likely to be admitted to NH. We do not know the underlying explanation for these findings, although one might speculate the representation of rural and black populations. In general, rural residents are not more likely to be admitted to NH than their urban counterparts.[51] As a final point, we noted that depression had a significantly disproportionate effect on men with HF, which persisted after multivariable adjustment.

Our study has several strengths in that our participants came from a representative national sample and thus the findings are more generalizable. By matching subjects based on propensity scores, we were able to balance all measured baseline covariates between patients with and without depression. Finally, because odds ratios are likely to overestimate true associations, especially when the outcome is common (>10%), we were able to convert and present our estimates as risk ratios.[37,52]

Several limitations must be acknowledged. Secondary diagnosis of depression was ascertained using ICD-9 codes based on administrative data. This in part explains the lower prevalence of depression (Table 1) observed in our study compared with other studies.[17,18] This may be compounded by the fact that depression was not actively managed during the short hospital stay that was focused on HF exacerbation. We were also unclear as to what criteria were used to capture depression as a secondary diagnosis. It is possible that patients who were depressed in our analysis included those with major symptomatic depression or that depression was assigned to patients who were receiving antidepressants. Nonetheless, the possible misclassification of nondepression has likely underestimated the observed effects of depression on NH admission. Thus, it is possible that many depressed patients were randomly misclassified as not having depression. This random misclassification most likely underestimated the true effects of depression. In addition, if patients were given a secondary diagnosis of depression because of receipt of antidepressants that also might have increased the similarity between the two groups. We were not able to adjust for important variables such as severity of depression and therapy with antidepressants. NHDS racial data are incomplete and thus the results of the race-based subgroup analysis need to be interpreted with caution.[53] Finally, bias resulting from unmeasured covariates, including those related to psychosocial constructs of depression, could not be ruled out.

In conclusion, we demonstrated that depression was associated with increased risk of admission to NH among ambulatory older adults hospitalized with HF. Future prospective studies should examine the impact of depression on mortality and morbidity in older adults with HF in both the community and hospital settings, and if the adverse effects of depression can be reduced by therapy with antidepressants.

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