

Association of Psychological Disorders With 30-Day Readmission Rates in Patients With COPD



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BACKGROUND: There is a growing understanding of the prevalence and impact of psychological disorders on COPD. However, the role of these disorders in early readmission is unclear.

METHODS: We analyzed data from 5% fee-for-service Medicare beneficiaries diagnosed with COPD (*International Classification of Diseases, Ninth Revision* code, 491.xx, 492.xx, 493.xx, and 496.xx) between 2001 and 2011 who were hospitalized with a primary discharge diagnosis of COPD or a primary discharge diagnosis of respiratory failure (518.xx and 799.1) with secondary diagnosis of COPD. We hypothesized that such psychological disorders as depression, anxiety, psychosis, alcohol abuse, and drug abuse are independently associated with an increased risk of 30-day readmission in patients hospitalized for COPD.

RESULTS: Between 2001 and 2011, 135,498 hospitalizations occurred for COPD in 80,088 fee-for-service Medicare beneficiaries. Of these, 30,218 (22.30%) patients had one or more psychological disorders. In multivariate analyses, odds of 30-day readmission were higher in patients with COPD who had depression (OR, 1.34; 95% CI, 1.29-1.39), anxiety (OR, 1.43; 95% CI, 1.37-1.50), psychosis (OR, 1.18; 95% CI, 1.10-1.27), alcohol abuse (OR, 1.30; 95% CI, 1.15-1.47), and drug abuse (OR, 1.29; 95% CI, 1.11-1.50) compared with those who did not have these disorders. These psychological disorders increased amount of variation in 30-day readmission attributed to patient characteristics by 37%.

CONCLUSIONS: Psychological disorders like depression, anxiety, psychosis, alcohol abuse, and drug abuse are independently associated with higher all-cause 30-day readmission rates for Medicare beneficiaries with COPD. CHEST 2016; 149(4):905-915

KEY WORDS: anxiety; COPD; depression; medicare; readmission

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ABBREVIATIONS: CMS = Centers for Medicare & Medicaid Services; ICD-9 = *International Classification of Diseases, Ninth Revision*

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Psychological disorders are common in patients with COPD. Up to 55% of patients with COPD suffer from clinical diagnoses of anxiety or depression.¹⁻³ The true prevalence of these conditions in patients with COPD varies and depends upon the measurement tool used for their assessment.⁴⁻⁶ Studies examining the effect of psychological disorders in patients with COPD have shown that such patients have more visits to the primary care physician and ED,^{7,8} greater risk of exacerbation⁷⁻¹¹ and hospitalization,^{8,9} as well as longer hospital stays^{2,9} and higher risk of death,^{2,3,9,11,12} than patients with COPD in good mental health.

Early readmission following hospitalization for COPD is common and occurs in almost one in five discharges among older adults.^{13,14} Reasons for early readmission are complex, and may be related to underlying clinical severity of the disorder,¹⁵ coexisting comorbidities,¹⁶⁻¹⁸

psychological disorders,^{2,8,9,19} and some elements of care transition such as lack of early follow-up.^{18,20} Rehospitalizations among elderly patients with COPD costs around \$924 million annually.²¹ As of October 2014, COPD hospitalization joins the list of conditions like acute myocardial infarction, congestive heart failure, and pneumonia, which the Centers for Medicare & Medicaid Services (CMS) will use to estimate penalties for excess early rehospitalizations under the Hospital Readmission Reduction Program.²²

Although there is growing understanding about the impact of psychological disorders on COPD, their role in early readmission is not yet known. Using a 5% sample of Medicare beneficiaries, we examined the association of psychological disorders such as depression, anxiety, psychosis, alcohol abuse, and drug abuse with early readmission for patients with COPD.

Materials and Methods

Data Source

This study used files from the 5% Medicare sample from 2001 to 2011 provided by Research Data Assistance Center (ResDAC).²³ The CMS select a random sample of 5% Medicare beneficiaries based on the eighth and ninth digits (05, 20, 45, 70, and 95) of their health insurance claim number; this is the standard dataset available for research purposes and has been shown to be representative of the whole cohort. The study was approved by the University of Texas Medical Branch institutional review board (project 09-054).

Study Cohort

Subjects were selected for this analysis if they were admitted to an acute care hospital on or after January 1, 2001 and discharged before December 1, 2011 for COPD, were 66 years of age or older, and were enrolled in both Medicare parts A and B but not in a health maintenance organization from 1 year prior to 1 month after the index admission.²⁴ Exclusion criteria included: in-hospital death, same-day transfer, transfer to other acute care hospital, transfer from other hospital or skilled nursing facility, and not being a resident in one of nine United States geographic regions.^{24,25} COPD was defined as (1) hospitalization with a primary *International Classification of Diseases, Ninth Revision* (ICD-9) code for COPD (491.21, 491.22, 491.8, 491.9, 492.8, 493.20, 493.21, 493.22, and 496); or (2) primary ICD-9 codes of 518.81, 518.82, 518.84, or 799.1 and secondary ICD-9 codes for COPD (491.21, 491.22, 493.21, and 493.22). An "index admission" is the one in which we evaluate the 30 days after discharge for a readmission. A patient can have multiple index admission in our study cohort, and we excluded admissions for which a patient was admitted within the previous 30 days, similar to CMS methodology.^{24,25}

Variables

Subject demographic characteristics were obtained from the denominator file and included the following: age, sex, race, regions, year of discharge, and socioeconomic status. Low socioeconomic

status was based on eligibility for at least 1 month during the index year for state buy-in coverage provided by the Medicaid program.²⁶ The index admission characteristics included length of stay in the hospital, ICU or cardiac care unit stay, mechanical ventilator use, discharge destination, follow-up visit within 30 days of discharge, and number of Elixhauser comorbidities (0, 1, 2, > 2).²⁷ Our interests also included comorbidities, such as depression, anxiety, psychosis, alcohol abuse, and drug abuse, which were identified with ICD-9 codes based on Elixhauser comorbidity index.²⁷⁻²⁹ We also examined the most common reasons for 30-day readmission in patients discharged after treatment of COPD.

Outcomes

Our primary outcome of interest was the all-cause 30-day readmission rate for patients with COPD with and without coexisting psychological disorders. We also examined the effect of these psychological disorders on the variation in 30-day readmission at the patient level.

Statistical Analysis

Characteristics were expressed as mean \pm SD for continuous variables and as percentages for categorical variables. Categorical variables were compared using the χ^2 test. A generalized estimating equation model was used to examine the risk of 30-day readmission, adjusted by demographic characteristics, hospital characteristics, and five psychological disorders. The cluster effect of multiple admissions in a year was accounted for in the generalized estimating equation model. Generalized R^2 values were used to compare different models.³⁰ We then randomly selected one index admission per patient per year to compare the 30-day readmission rates for different psychological disorder combinations. Sensitivity analyses were performed by (1) excluding cases with asthma (ICD-9: 493.XX), (2) randomly selecting one admission per patient per year, and (3) adjusting for clustering at patient level during the entire study period. All analyses were performed with SAS version 9.2 (SAS Institute Inc). All reported P values were two-sided, and $P < .05$ was considered statistically significant.

TABLE 1] Baseline Characteristics of Hospitalized Patients With COPD, 2001-2011, With and Without Psychological Disorders

Demographic Characteristic	Psychological Disorders		
	Yes	No	P Value
Total	30,218 (22.30)	105,280 (77.70)	...
DRG weight, mean (SD)	1.10 (0.72)	1.09 (0.69)	.03 ^a
Age group, y			< .0001 ^b
66-74	14,684 (48.59)	43,483 (41.30)	
75-84	11,827 (39.14)	45,853 (43.55)	
≥ 85	3,707 (12.27)	15,944 (15.14)	
Sex			< .0001 ^b
Female	21,307 (70.51)	60,251 (57.23)	
Male	8,911 (29.49)	45,029 (42.77)	
Race			< .0001 ^b
White	27,170 (89.91)	90,971 (87.36)	
Black	2,081 (6.89)	9,201 (8.74)	
Other	967 (3.20)	4,108 (3.90)	
Low socioeconomic status ^c			< .0001 ^b
No	18,988 (62.84)	79,795 (75.79)	
Yes	11,230 (37.16)	25,485 (24.21)	
Year of discharge			< .0001 ^b
2001	2,143 (7.09)	9,086 (8.63)	
2002	2,309 (7.64)	9,483 (9.01)	
2003	2,596 (8.59)	9,525 (9.05)	
2004	2,522 (8.35)	9,116 (8.66)	
2005	2,744 (9.08)	10,103 (9.60)	
2006	2,577 (8.53)	9,383 (8.91)	
2007	2,387 (7.90)	8,455 (8.03)	
2008	2,674 (8.85)	9,560 (9.08)	
2009	2,955 (9.78)	10,066 (9.56)	
2010	3,440 (11.38)	9,881 (9.39)	
2011	3,871 (12.81)	10,622 (10.09)	
Region			< .0001 ^b
New England	2,063 (6.83)	5,583 (5.30)	
Middle Atlantic	4,009 (13.27)	14,847 (14.10)	
East North Central	5,848 (19.35)	19,662 (18.68)	
West North Central	1,637 (5.42)	6,770 (6.43)	
South Atlantic	7,053 (23.34)	23,674 (22.49)	
East South Central	3,193 (10.57)	10,431 (9.91)	
West South Central	3,419 (11.31)	12,315 (11.70)	
Mountain	954 (3.16)	3,944 (3.75)	
Pacific	2,042 (6.76)	8,054 (7.65)	
Length of stay, mean (SD)	5.04 (3.21)	4.80 (3.11)	< .0001 ^b
ICU stay			.32 ^a
Yes	9,078 (30.04)	31,313 (29.74)	
No	21,140 (69.96)	73,967 (70.26)	

(Continued)

TABLE 1] (Continued)

Demographic Characteristic	Psychological Disorders		
	Yes	No	P Value
Mechanical ventilator^d			.09^a
Yes	1,123 (3.72)	3,699 (3.51)	
No	29,095 (96.28)	101,581 (96.49)	
Discharge destination			< .0001^b
Home ^e	21,899 (72.47)	90,297 (85.77)	
SNF	6,334 (20.96)	10,557 (10.03)	
Hospice	279 (0.92)	597 (0.57)	
Other	1,706 (5.65)	3,829 (3.64)	
30-d Outpatient visit			< .0001^b
Yes	19,105 (63.22)	78,313 (74.39)	
No	11,113 (36.78)	26,967 (25.61)	
30-d Readmission			< .0001^b
Yes	7,192 (23.80)	17,112 (16.25)	
No	23,026 (76.20)	88,168 (83.75)	
No. of comorbidities^f			< .0001^b
0	1,375 (4.55)	17,390 (16.52)	
1	3,571 (11.82)	21,351 (20.28)	
2	4,907 (16.24)	20,140 (19.13)	
> 2	20,365 (67.39)	46,399 (44.07)	

Data are shown as No. (%) unless otherwise indicated. DRG = diagnosis-related group; ICD-9 = *International Classification of Diseases, Ninth Revision*; SNF = skilled nursing facility.

^aIndicates not statistically significant, as *P* value is not < .0001.

^bIndicates statistically significant, as *P* < .0001.

^cSocioeconomic status was based on whether the patient was eligible for state buy-in coverage provided by the Medicaid program for at least 1 mo during the calendar year under study.

^dICD-9 procedure codes used for invasive mechanical ventilation were 96.70-96.72.

^eDischarge destination to home included patient's discharged to home with or without home health.

^fComorbidities were identified using the Elixhauser Comorbidity Index (excluded chronic pulmonary disease, alcohol abuse, drug abuse, psychosis, and depression).

Results

Between 2001 and 2011, 135,498 hospitalizations occurred for COPD in 80,088 fee-for-service Medicare patients. Of these, 30,218 (22.30%) patients had one or more coexisting psychological disorders, with highest prevalence in most recent years, as noted in earlier studies.^{31,32} Table 1 shows the baseline characteristics of the cohort stratified according to presence of these psychological disorders. Relative to patients with COPD without coexisting psychological disorders, patients with these psychological disorders were younger, were more likely to be female and non-Hispanic white, and tended to have low socioeconomic status (all *P* < .0001). Patients with COPD with these psychological disorders had longer length of stay during the index hospitalization (mean, 5.04 days vs 4.80 days; *P* < .0001) and had more discharges to a skilled nursing facility (20.96% vs 10.03%, *P* < .0001). However, admission

to ICU or cardiac care unit and use of mechanical ventilation during the index hospitalization was similar for the two groups. Patients with COPD with coexisting psychological disorders had a lower rate of outpatient follow-up visits within 30 days after acute hospitalization (63.22% vs 74.39%, *P* < .0001) and had a higher 30-day readmission rate (23.80% vs 16.25%, *P* < .0001) compared with those without these disorders.

Table 2 presents the select coexisting psychological disorders and 30-day readmission rates for this cohort. Among all categories, 30-day readmission rates were significantly higher in patients with depression (24.15% vs 16.91%, *P* < .0001), anxiety (25.38% vs 17.15%, *P* < .0001), psychosis (25.34% vs 17.68%, *P* < .0001), alcohol abuse (26.49% vs 17.84%, *P* < .0001), and drug abuse (27.90% vs 17.86%, *P* < .0001) compared with those who did not have these conditions.

TABLE 2] Select Psychological Disorders and 30-Day Readmission Rates

Comorbidity ^a	Overall	30-d Readmission	P Value
Depression ^b			< .0001 ^c
Yes	19,293 (14.24)	4,659 (24.15)	
No	116,205 (85.76)	19,645 (16.91)	
Anxiety ^d			< .0001 ^c
Yes	12,948 (9.56)	3,286 (25.38)	
No	122,550 (90.44)	21,018 (17.15)	
Psychosis			< .0001 ^c
Yes	4,511 (3.33)	1,143 (25.34)	
No	130,987 (96.67)	23,161 (17.68)	
Alcohol abuse			< .0001 ^c
Yes	1,529 (1.13)	405 (26.49)	
No	133,969 (98.87)	23,899 (17.84)	
Drug abuse			< .0001 ^c
Yes	1,018 (0.75)	284 (27.90)	
No	134,480 (99.25)	24,020 (17.86)	

Data are given as No. (%). See Table 1 legend for expansion of abbreviation.

^aICD-9 codes used for psychological comorbidities based on Elixhauser Comorbidity Index: depression (296.2, 296.3, 300.4, 301.12, 309.0, 309.1, 311), anxiety (300.00-300.09), psychosis (295.0-296.1, 296.3-298.9), alcohol abuse (291.0-291.3, 291.5, 291.8, 291.81, 291.89, 291.9, 303.00-303.93, V113), and drug abuse (292.0, 292.82-292.89, 292.9, 304.00-304.93, 305.20-305.93, 648.30-648.34).

^bICD 9 codes 296.2-296.3 (major depression, single and recurrent episodes) included in depression rather than psychosis to have good cross-walk between ICD-9 and *Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition*.

^cIndicates statistically significant, as $P < .0001$.

^dICD 9 codes 300.00-300.09 (anxiety) classified separately from psychosis to have good cross-walk between ICD-9 and *Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition*.

Table 3 shows the additive effect of psychological disorders on 30-day readmission rates. As shown, patients with coexisting disorders like depression, anxiety, and psychosis have a significantly higher 30-day readmission rate at 29.73% compared with those with

TABLE 3] Effect of Coexisting Psychological Disorders on 30-Day Readmission Rate

Coexisting Psychological Condition	No. ^a	30-d Readmission Rate, %
None	14,105	15.49
Depression	2,009	20.98
Anxiety	1,019	20.99
Psychosis	343	19.60
Alcohol use	133	22.54
Drug use	54	21.60
Depression + anxiety	714	24.04
Anxiety + psychosis	71	29.83
Depression + anxiety + psychosis	132	29.73

Percentage of five psychological disorders in different combinations among patients (patients in different years were considered as different patients) with 30-d readmission.

^aWe randomly selected only one index admission per patient per year.

only depression (20.98%), anxiety (20.99%), or psychosis (19.60%) or those with none (15.49%) of these disorders.

COPD is the most common reason for readmission within 30 days of discharge (30.89%), followed by pneumonia (10.62%) and heart failure (6.55%). The top 10 reasons for readmission were similar for patients with and without psychological disorders.

Table 4 presents the results of multivariable analysis of factors associated with 30-day readmission. In model 1 (Table 4), patient characteristics such as male sex, year of discharge, region, length of index hospital stay, and ICU stay were associated with higher odds of readmission.

Model 2 (Table 4) examines additional variables like race, low socioeconomic status, and coexisting psychological disorders. Patients with COPD with low socioeconomic status had higher odds of 30-day readmission (OR, 1.22; 95% CI, 1.18-1.26). Race was not associated with higher rates of readmission when controlled for all other factors. The effect of depression, anxiety, psychosis, alcohol abuse, and drug abuse on 30-day readmission is much higher than that of sex, ICU stay, or use of mechanical ventilation during index

TABLE 4] Multivariable, Multilevel Analysis of Patient's Index Hospitalization Characteristics on Odds of Readmission Within 30 Days of Discharge

Variable	Odds of Readmission (95% CI)	
	Model 1 ($R^2 = 0.0185$)	Model 2 ($R^2 = 0.0254$)
Age for every 5 y	0.97 (0.96-0.98) ^a	0.99 (0.98-1.00) ^b
DRG	0.99 (0.97-1.02) ^b	1.00 (0.98-1.03) ^b
Sex		
Female	1	1
Male	1.08 (1.05-1.11) ^a	1.15 (1.12-1.19) ^a
Race		
White	...	1
Black	...	1.04 (0.99-1.10) ^b
Other	...	0.91 (0.84-0.98) ^a
Low socioeconomic status		
No	...	1
Yes	...	1.22 (1.18-1.26) ^a
Year of discharge		
2001	1	1
2002	0.96 (0.89-1.03) ^b	0.96 (0.89-1.03) ^b
2003	0.98 (0.91-1.05) ^b	0.97 (0.91-1.04) ^b
2004	1.00 (0.93-1.07) ^b	0.99 (0.92-1.06) ^b
2005	0.95 (0.89-1.02) ^b	0.94 (0.88-1.01) ^b
2006	1.02 (0.95-1.09) ^b	1.00 (0.93-1.07) ^b
2007	1.01 (0.94-1.08) ^b	0.99 (0.92-1.06) ^b
2008	1.07 (1.00-1.15) ^b	1.06 (0.99-1.13) ^b
2009	1.05 (0.98-1.12) ^b	1.02 (0.96-1.10) ^b
2010	1.03 (0.96-1.10) ^b	0.98 (0.92-1.05) ^b
2011	1.30 (1.21-1.39) ^a	1.24 (1.16-1.33) ^a
Region		
New England	1	1
East North Central	0.97 (0.91-1.04) ^b	1.00 (0.93-1.07) ^b
East South Central	0.98 (0.91-1.06) ^b	0.98 (0.91-1.06) ^b
Middle Atlantic	1.00 (0.93-1.07) ^b	1.04 (0.96-1.11) ^b
Mountain	0.80 (0.73-0.89) ^a	0.84 (0.76-0.93) ^a
Pacific	0.89 (0.82-0.96) ^a	0.90 (0.83-0.97) ^a
South Atlantic	0.92 (0.86-0.99) ^a	0.94 (0.88-1.00) ^b
West North Central	0.96 (0.88-1.04) ^b	1.00 (0.92-1.09) ^b
West South Central	0.89 (0.82-0.96) ^a	0.91 (0.84-0.98) ^a
Length of stay, d		
1-2	1	1
3-5	1.07 (1.03-1.11) ^a	1.07 (1.03-1.11) ^a
5-7	1.23 (1.18-1.28) ^a	1.23 (1.18-1.28) ^a
> 7	1.46 (1.39-1.54) ^a	1.47 (1.40-1.55) ^a
ICU stay		
No	1	1
Yes	1.11 (1.07-1.14) ^a	1.12 (1.08-1.15) ^a

(Continued)

TABLE 4] (Continued)

Variable	Odds of Readmission (95% CI)	
	Model 1 ($R^2 = 0.0185$)	Model 2 ($R^2 = 0.0254$)
Mechanical ventilation		
No	1	1
Yes	1.00 (0.90-1.10) ^b	1.00 (0.90-1.10) ^b
Discharge destination		
Home	1	1
SNF	0.93 (0.89-0.97) ^a	0.84 (0.81-0.88) ^a
Hospice	0.21 (0.16-0.28) ^a	0.20 (0.16-0.27) ^a
Others	0.75 (0.69-0.81) ^a	0.70 (0.65-0.76) ^a
Outpatient visit		
No	1	1
Yes	0.54 (0.52-0.56) ^a	0.56 (0.55-0.58) ^a
Depression		
No	...	1
Yes	...	1.34 (1.29-1.39) ^a
Anxiety		
No	...	1
Yes	...	1.43 (1.37-1.50) ^a
Psychosis		
No	...	1
Yes	...	1.18 (1.10-1.27) ^a
Alcohol abuse		
No	...	1
Yes	...	1.30 (1.15-1.47) ^a
Drug abuse		
No	...	1
Yes	...	1.29 (1.11-1.50) ^a

Data represent odds of readmission (95% CI). Model 1: adjusted by age, sex, region, and year of discharge, length of stay, mechanical ventilator, ICU, discharge destination, and 30-d outpatient follow-up. Model 2: adjusted by Model 1 + race, low socioeconomic status, and coexisting psychological disorders. See Table 1 legend for expansion of abbreviations.

^aIndicates results are statistically significant.

^bIndicates results are not statistically significant.

hospitalization. The R^2 increased from 0.0185 in model 1 to 0.0254 in model 2. This indicated that the psychological disorders increased amount of variation in 30-day readmission attributed to patient characteristics by 37%. In model 2, the addition of psychological disorders modestly weakened the association of age but strengthened the association of male sex and discharge to skilled nursing facility with 30-day readmission.

Finally, we did sensitivity analyses by (1) excluding patients with asthma (ICD-9, 493.xx), (2) randomly selecting one admission per patient per year, and (3) adjusting for clustering at patient level during the entire study period. The magnitude and the direction of association between these psychological disorders and

30-day readmission were similar across all these analyses (data not shown).

Discussion

In this retrospective cohort study, we found that psychological disorders such as depression, anxiety, psychosis, alcohol abuse, and drug abuse contribute significantly to the 30-day readmission rate for elderly patients with COPD. Similar to prior studies, we found that patients with COPD with low socioeconomic status,^{33,34} psychosis,³⁵ and alcohol abuse³⁶ had higher readmission rates. This is likely related to limited capacity of these patients to meet the workload of disease burden, poor social support, and nonadherence

with treatment. Patients with more than one of these coexisting psychological disorders and low socioeconomic status have even higher readmission rates, suggesting the additive effect of these factors on readmission rates, as noted in earlier studies.^{9,37,38} Moreover, these factors explained a large proportion of variation in 30-day readmission rates. These psychological disorders are more likely to predict 30-day readmission than other significant factors like male sex and measures of disease severity such as length of hospital stay, ICU stay, and use of mechanical ventilation during the index hospitalization.¹⁸ Lower 30-day outpatient follow-up after acute hospitalization in patients with coexisting psychological disorders may have contributed to the higher odds of readmission, as noted in earlier studies.²⁰ Lack of community resources to meet the transportation needs or clinic copayment may play a role in clinic absenteeism. Less than one-third of readmissions are related to acute exacerbation of COPD; the remainder are related to other comorbidities,^{37,39} and the number of comorbidities correlates directly with frequency of 30-day readmission.^{16,18,40,41}

The complex overlap of symptoms with COPD creates challenges for the diagnosis and treatment of comorbid psychological disorders.^{42,43} The potential biologic mechanism linking depression to exacerbation of COPD and consequent hospitalization is likely related to chronic psychological stress. This condition can activate the sympathetic nervous system and the hypothalamic-pituitary-adrenal axis, leading to a weakened immune system and increased vulnerability to respiratory infection and exacerbation of COPD.⁴⁴⁻⁴⁶ Depressed patients also have lower self-confidence, greater feelings of hopelessness, and increased apathy.^{6,47} Depression contributes to suboptimal disease control due to poor self-care and lack of motivation to seek help, resulting in nonadherence to medication,⁴⁸ less likelihood of quitting smoking,^{49,50} and poor participation in pulmonary rehabilitation,⁵¹ leading to ineffective COPD management. The result is often increased risk of exacerbation,⁷⁻¹¹ hospital admission,^{8,9} and early death.^{2,3,9,11,12}

For patients with COPD with coexisting anxiety and in particular panic disorder, misinterpretation of the cause of dyspnea may lead to heightened arousal, followed by additional negative cognitions not found in those without panic attacks.⁵² A meta-analysis has also suggested a bidirectional relationship between comorbid COPD and depression or anxiety,¹¹ as depression or anxiety may be both a cause and a consequence of COPD outcome.

Harmful effect of alcohol at the cellular level is well known,⁵³ but its impact on lung parenchyma is less clear. Heavy alcohol use and risk of exacerbation is biologically plausible through immune suppression and increased risk of aspiration. In a large prospective Veterans Affairs study, heavy consumption of alcohol was associated with increased risk of exacerbation but was confounded by tobacco use, which is strongly associated with alcohol consumption.⁵⁴

Growing evidence supports the use of pharmacotherapy to treat patients with COPD with depression and anxiety to improve depression, anxiety, respiratory symptoms, and functional status in these patients.^{55,56} Qian et al¹² showed lower all-cause mortality at 2 years in Medicare beneficiaries with COPD who received antidepressants to treat their depression. However, the effect of pharmacotherapy for psychological disorders on the risk of exacerbations and hospitalizations in patients with COPD has not been shown.⁵⁷ Pulmonary rehabilitation and psychotherapy have been shown to reduce anxiety and depressive symptoms and improve quality of life in patients with COPD,⁵⁸⁻⁶² but the overall use of pulmonary rehabilitation in the COPD population is low.⁶³

Many of these patients with low socioeconomic status and psychological disorders get admitted to safety net hospitals, so readmission rate could vary in proportion to the number of patients with these psychological disorders cared for by a safety net hospital. Hospitals with a disproportionate share of patients with these disorders will be more likely to have higher rates of readmission and risk getting penalized, even though most of these conditions are nonmodifiable.⁶⁴ Because of scarce evidence in literature to support any interventions to reduce readmissions in patients with COPD,⁶⁵⁻⁶⁸ hospitals and health-care providers need more guidance to reduce readmission in patients with COPD, and it may not be practical to penalize hospitals for higher 30-day readmission rates. Clearly, more studies are needed in this area.

Our study has a number of limitations. First, we used ICD-9 codes to identify patients hospitalized with COPD. The validity of ICD-9 codes for claim-based diagnosis has been found to tend to underestimate hospitalizations for acute exacerbation of COPD.⁶⁹ Furthermore, use of ICD-9 diagnostic code-based information alone may be problematic for accurately identifying patients with psychological disorders,⁷⁰ given that physicians tend to under-code these psychological

diagnoses as they fail to recognize them.⁷¹ However, similar codes are used in Elixhauser comorbidity measures and other large population studies in patients with COPD.^{12,72,73} Second, we examined only severe exacerbations leading to hospitalizations and did not include outpatient or ED visits, which may have underestimated the number of acute exacerbations in our study cohort. Third, as always with the use of administrative claim-based data, we do not have information on severity of COPD and complexity of index hospitalization, and these factors may confound the rate of readmission. However, we used ICU stay and mechanical ventilation as a surrogate for severity of

index hospitalization. Fourth, the study was limited to patients aged 66 years and older with Medicare parts A and B coverage; these results may not be generalizable to younger patients with COPD. Finally, we did not examine whether the underlying psychological disorders were treated with pharmacologic or behavioral therapy. Evidence is limited regarding the effect of treatment of depression or anxiety on readmission, and this topic requires further investigation. In conclusion, our study showed that low socioeconomic status and psychological disorders are independently associated with higher all-cause 30-day readmission rates in Medicare beneficiaries with COPD.

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