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# Psychiatric Comorbidity and Greater Hospitalization Risk, Longer Length of Stay, and Higher Hospitalization Costs in Older Adults with Heart Failure

## Abstract

**OBJECTIVES:** To explore associations between psychiatric comorbidity and rehospitalization risk, length of hospitalization, and costs.

**DESIGN:** Cross-sectional study of 1-year hospital administrative data.

**SETTING:** Claims-based study of older adults hospitalized in the United States.

**PARTICIPANTS:** Twenty-one thousand four hundred twenty-nine patients from a 5% national random sample of U.S. Medicare beneficiaries aged 65 and older, with at least one acute care hospitalization in 1999 with a Diagnostic-Related Group of congestive heart failure.

**MEASUREMENTS:** The number of hospitalizations, mean length of hospital stay, and total hospitalization costs in calendar year 1999.

**RESULTS:** Overall, 15.8% of patients hospitalized for heart failure (HF) had a coded psychiatric comorbidity; the most commonly coded comorbid psychiatric disorder was depression (8.5% of the sample). Most forms of psychiatric comorbidity were associated with greater inpatient utilization, including risk of additional hospitalizations, days of stay, and hospitalization charges. Additional hospitalization costs associated with psychiatric comorbidity ranged up to \$7,763, and additional days length of stay ranged up to 1.4 days.

**CONCLUSION:** Psychiatric comorbidity appears in a significant minority of patients hospitalized for HF and may affect their clinical and economic outcomes. The associations between psychiatric comorbidity and use of inpatient care are likely to be an underestimate, because psychiatric illness is known to be underdetected in older adults and in hospitalized medical patients.

## Keywords

heart failure, psychiatric comorbidity, depression, hospitalization costs, economic analysis, Medicare, sex, socioeconomic status, race, ethnicity

## Disciplines

Cardiology | Cardiovascular Diseases | Circulatory and Respiratory Physiology | Geriatrics | Health and Medical Administration | Medical Humanities | Medicine and Health Sciences | Nursing | Psychiatry | Psychiatry and Psychology

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Psychiatric Comorbidity and Increased Hospitalization Risk, Length of Stay,  
and Hospitalization Costs in Older Adults with Heart Failure

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## Abstract

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13 the sample). Most forms of psychiatric comorbidity were associated with increases in inpatient  
14 utilization, including risk of additional hospitalizations, additional days of stay, and additional  
15 hospitalization charges. Additional hospitalization costs associated with psychiatric comorbidity  
16 ranged up to \$7763 and additional days length of stay ranged up to 1.4 days.

17 **CONCLUSION:** Psychiatric comorbidity appears in a significant minority of patients  
18 hospitalized for heart failure and may affect their clinical and economic outcomes. The  
19 associations of psychiatric comorbidity with utilization of inpatient care are likely to be an  
20 underestimate because psychiatric illness is known to be underdetected in older adults and in  
21 hospitalized medical patients.

- 22 **KEYWORDS:** Heart failure, psychiatric comorbidity, depression, hospitalization costs, economic  
23 analysis, Medicare, gender, socioeconomic status, race/ethnicity
- 24 Word count of abstract: 214 words

## 25 INTRODUCTION

26 Currently, over 5 million Americans have heart failure,<sup>1</sup> with increasing prevalence in older  
27 cohorts of adults, largely due to the aging U.S. population and increased survival of patients with  
28 heart failure. Despite medical advances<sup>2</sup> and the positive impact of heart failure management  
29 programs,<sup>3</sup> the cost of care for heart failure remains high. Heart failure is responsible for \$33.2  
30 billion in health care costs in the U.S., approximately 1.5% of total health care expenditure.<sup>3</sup>  
31 Hospitalizations account for 65% of the costs of treating heart failure.<sup>3</sup>

32 There is significant evidence that comorbid psychiatric disorders contribute to increased  
33 risk of hospitalization among patients with heart failure and increased costs of these  
34 hospitalizations.<sup>4</sup> Depression is common among hospitalized older adults with heart failure,<sup>5</sup> and  
35 likely leads to increased outpatient utilization, higher health care costs, and to a doubled risk of  
36 rehospitalization and death within 1 year.<sup>6</sup> Few studies have examined the consequences of a broad  
37 range of psychiatric disorders for hospitalized older adults with heart failure (e.g., anxiety  
38 disorders, alcohol abuse), despite evidence of increased rates of these problems in the heart failure  
39 population.<sup>7</sup>

40 The goal of this study was to examine the effects of identified comorbid psychiatric  
41 disorders on healthcare utilization and costs in a sample of Medicare beneficiaries hospitalized at  
42 least once with a primary diagnosis of heart failure in 1999. Our major hypothesis was that having  
43 a psychiatric disorder would be associated with increased rates of hospitalization, length of  
44 hospitalizations, and hospitalization costs in older adults with heart failure. Consistent with  
45 existing findings we hypothesized that identified comorbid psychiatric disorders might vary across  
46 groups defined by gender, socioeconomic status,<sup>8</sup> and race<sup>9</sup> and that these variables, as well as

47 medical comorbidities, would require controls in our models examining the association between  
48 psychiatric comorbidities and health care utilization.

49

## 50 **METHODS**

### 51 **Study Sample**

52           The study sample was drawn from a 5% random national sample of Medicare beneficiaries  
53 hospitalized during the 1999 calendar year. Using the Denominator and MedPAR files obtained  
54 from the Center for Medicaid and Medicare Services (CMS), we extracted records of  
55 hospitalizations in 1999 that were assigned the Congestive Heart Failure Diagnostic-Related  
56 Grouping (DRG 127). Records of different hospitalizations for the same patients were then  
57 collapsed so that the patient became the unit of analysis for most analyses. Because we used  
58 hospital DRGs to identify target patients, we excluded patients for whom heart failure was not a  
59 primary cause of any admission during 1999, even though it might have been a contributory cause  
60 for an admission during that year. This approach was used to limit the extent to which we included  
61 patients without a chronic heart failure condition. We excluded patients with comorbid dementia or  
62 organic brain syndrome diagnosis from the sample because they might exhibit less variability in  
63 their clinical course and the associated costs compared to those with other psychiatric  
64 disturbances.<sup>10, 11</sup>

65           Of the 5% national sample of 357,232 unique patients, a total of 27,949 patients had a CHF  
66 DRG during at least one of their hospitalizations for that year. About one-fifth of these patients  
67 were excluded due to dementia or organic brain syndrome (n=3,123, 11.1%), or an age less than 65  
68 years (n=2,628, 9.4%) because persons younger than 65 years may have qualified for Medicare  
69 coverage on the basis of physical or mental disability. A further 2.8% (n = 769) were excluded on  
70 the basis of having been admitted before the year 1999, hospitalization costs suggesting data entry  
71 errors, or stays longer than 365 days suggestive of long-term care rather than acute



72 hospitalizations. The final sample included 21,429 individuals with a CHF DRG for at least one of  
73 their hospital stays during the year 1999.

#### 74 **Measures**

75 We used the definitions of medical comorbidity indices as described by Elixhauser and  
76 colleagues<sup>12</sup> and used their algorithm as applied in publicly-available software code distributed by  
77 the Agency for Healthcare Research and Quality (AHRQ).<sup>13</sup> The algorithm places emphasis on  
78 comorbidities that could increase resources used or the risk of poor outcomes that are not directly  
79 related to the reason for admission.<sup>12</sup> Because of our focus on heart failure, it was not analyzed as a  
80 separate comorbidity in our analyses.

81 For the current study we expanded Elixhauser and colleagues'<sup>12</sup> categories of comorbid  
82 psychiatric disorders based on the initial work by Hanrahan,<sup>14</sup> as well as evidence for inclusion of  
83 disorders not represented in the system.<sup>7</sup> Psychiatric diagnoses within each category were  
84 identified using AHRQ's Clinical Classifications Software<sup>15</sup> (available from the first author upon  
85 request). Our final list of psychiatric comorbidity categories was as follows: alcohol abuse, drug  
86 abuse, psychosis, depression, bipolar disorders, anxiety disorders, and other psychiatric conditions.  
87 The variable we analyzed was presence vs. absence in any hospitalizations in 1999 of each type of  
88 comorbid medical and psychiatric condition.

89 The following demographic variables were analyzed: age, gender, and race. In addition, we  
90 used the receipt of Medicaid benefits anytime during the year 1999 as a proxy for socioeconomic  
91 status because so-called "dual" eligibility for Medicaid and Medicare requires falling below  
92 poverty levels defined by the U.S. Department of Health and Human Services.<sup>16</sup>

93 Our primary health care utilization and outcome included the patient's total number of  
94 hospitalizations in 1999, average length of stay (LOS) of all hospitalizations in 1999, and total  
95 hospitalization charges in 1999. All indices were collapsed across patients' hospitalizations for the  
96 year and represented the values for individual patients.

### 97 **Statistical Analyses**

98 Rates of psychiatric comorbidity were calculated, along with 95% confidence intervals.  
99 Relative proportions of the sample of patients with psychiatric diagnosis by gender, race, and low-  
100 income status were examined using 2 X 2 chi-square tests. The continuous outcomes of number of  
101 hospitalizations, average LOS, and total charges were all markedly positively skewed, but after  
102 logarithmic data transformation they approximated the normal distribution. These transformations  
103 were reversed for presentation purposes in the tables. The data were evaluated for amount,  
104 distribution, and patterns of missing data, out-of-range values, plausible means, and univariate  
105 outliers. Missing values were randomly scattered throughout and were less than 5% of the data  
106 points. Cases with incomplete data on the variables relevant for each analysis were dropped. Group  
107 differences were examined using *t*-tests and Satterthwaite's<sup>17</sup> method for estimating degrees of  
108 freedom for unequal variances where appropriate.

109 Presence of each type of psychiatric comorbidity was tested as a predictor of each outcome  
110 using regression modeling where the patient was the unit of analysis. Generalized linear modeling  
111 was used to test the hypothesis that psychiatric comorbidity explained a greater number of  
112 hospitalizations, mean LOS, and total hospitalization charges. Each of these analyses included the  
113 binomial variables (presence/absence) of each type of medical comorbidity as defined by  
114 Elixhauser et al.,<sup>12</sup> entered as a block along with the expanded psychiatric comorbidity  
115 categories. Because the continuous outcomes of hospitalizations, average LOS, and total charges

116 were all positively skewed, we considered log transformation, but we were concerned about  
117 retransformation bias. In order to select the correct model, we examined the distributions of the  
118 log-scale residuals from GLM models with a log link function following the method of Manning  
119 and Mullahy.<sup>18</sup> There was little kurtosis on the log-scale residuals (i.e., kurtosis < 3) so we chose  
120 GLM over ordinary least squares regression. Modified Park tests on the raw-scale residuals  
121 indicated that  $\lambda=2$  for each outcome, so the gamma family was selected for the final GLM models.  
122 To illustrate the impact of comorbidities on the outcome variables, estimates of effects of all  
123 comorbidity parameters from these models were transformed from the log values used for the  
124 analysis and then presented in a table. For parameters that were statistically significant, entries  
125 tabled were calculated using the parameter estimate for each effect and the intercept values of the  
126 major outcomes of interest that resulted from the significant model.

127

## 128 **RESULTS**

### 129 **Sample characteristics**

130 Table 1 presents the demographic and clinical characteristics of the final sample of 21,429  
131 heart failure patients. Over half of the patients were female (58.8%), and most were white (84.9%),  
132 and all were at least 65 years of age. Approximately one-fifth of the sample was designated as low-  
133 income and 33.8% died during the 1999 year. As shown in Table 1, the mean total hospitalization  
134 charges was \$40,048 but this outcome was highly skewed—the median value was \$22,934.

### 135 **Prevalence of psychiatric comorbidities in the sample**

136 Table 2 presents prevalence estimates of identified psychiatric comorbidity, drawn from  
137 every hospitalization of each patient in the sample. A significant minority of patients had at least  
138 one psychiatric comorbid condition recorded. Within this subset of patients, 15.8% (N=518) of  
139 patients had 2 or more different psychiatric diagnoses within or across any of their hospitalizations  
140 in that year. However, these patients did not have systematically greater patterns of hospitalization  
141 utilization. Those with more than one psychiatric diagnosis, compared to those with only one, had  
142 a greater number of hospitalizations,  $M = 5.5$ ,  $SD = 3.4$ , vs.  $M = 4.0$ ,  $SD = 2.6$ ,  $t(639) = 9.86$ ,  $p <$   
143  $.0001$ , but lower average costs per hospitalization,  $M = \$11,845$ ,  $SD = \$8,566$ , vs.  $M = \$12,914$ ,  
144  $SD = \$10,766$ ,  $t(835) = -2.51$ ,  $p < .05$ . The two groups did not differ on the mean length of  
145 hospitalizations,  $M = 8.8$ ,  $SD = 6.1$ , vs.  $M = 8.6$ ,  $SD = 7.5$ ,  $t(835) = 0.58$ ,  $p > .05$ .

### 146 **Psychiatric comorbidities in relation to gender, socioeconomic status, and race**

147 Women were more likely than men to have a comorbid psychiatric diagnosis, 16.8% vs.  
148 13.3%,  $\chi^2[1] = 48.82$ ,  $p < .0001$ ,  $N = 21,429$ . Depression and anxiety disorders were more  
149 common in women (10.0% vs. 6.3%,  $\chi^2[1] = 89.77$ , and 5.0% vs. 2.1%,  $\chi^2[1] = 114.01$ ,

150 respectively, both  $p$ 's  $< .0001$ ). Male patients were more likely than female patients to have an  
151 alcohol abuse diagnosis (2.5% vs. 0.5%,  $\chi^2[1] = 157.57, p < .0001$ ). No differences in rates of  
152 bipolar disorder, psychoses, drug abuse, or other psychiatric problems were observed by gender.

153 A higher proportion of low-income beneficiaries had psychiatric diagnoses, compared to all  
154 other beneficiaries, 18.7% vs. 14.4%,  $\chi^2[1] = 50.74, p < .0001, N = 21,429$ . Specifically, more  
155 low-income patients had diagnoses of psychosis (3.4% vs. 2.2%,  $\chi^2[1] = 21.38, p < .0001$ ),  
156 depression (10.1% vs. 8.1%,  $\chi^2[1] = 18.33, p < .0001$ ), drug abuse (0.9% vs. 0.5%,  $\chi^2[1] = 10.36, p$   
157  $< .005$ ), anxiety disorders (4.7% vs. 3.6%,  $\chi^2[1] = 14.17, p < .001$ ), and other psychiatric diagnoses  
158 (1.8% vs. 1.0%,  $\chi^2[1] = 21.24, p < .0001$ ). There were no differences in the likelihood of bipolar  
159 disorder or alcohol abuse disorders by income status.

160 Proportionally more White patients had a recorded psychiatric diagnosis than non-White  
161 patients (Black and other non-White categories combined), 15.8% vs. 12.4%,  $\chi^2[1] = 23.25, p <$   
162  $.0001$ ). Fewer Black patients had psychiatric diagnoses than those in the White or other race  
163 categories combined, 12.5% vs. 15.7%,  $\chi^2[1] = 16.3, p < .0001$ .

#### 164 **Psychiatric comorbidities as predictors of outcomes**

165 *Number of hospitalizations.* Consistent with our hypotheses, all types of psychiatric  
166 comorbidity were associated with a greater risk of hospitalizations,  $\chi^2(38) = 4008.30, p < .0001$ ,  
167 after adjusting for medical comorbidities (see Table 3). All forms of psychiatric comorbidity were  
168 associated with having at additional risk of hospitalization, ranging from .20 to .39 additional  
169 hospitalizations, on average. Sensitivity analyses excluding patients who had died during 1999  
170 revealed very similar findings indicating no significant effects due to an increase in number of  
171 hospitalizations at end of life.

172 Follow-up analyses indicated psychiatric comorbidity was associated with increased risk of  
173 hospitalizations specifically attributed to heart failure exacerbation (i.e., with a DRG of heart  
174 failure). The mean heart failure hospitalizations for patients with psychiatric comorbidity versus no  
175 psychiatric comorbidity, were  $M=1.59$  ( $SD=1.11$ ),  $M=1.35$  ( $SD=.80$ ) and respectively,  $t(3921)=-$   
176  $12.16$ ,  $p < .0001$ .

177 ***Mean length of stay (LOS)***. In partial support of our hypothesis, alcohol abuse, psychoses,  
178 major depression, and bipolar disorder were significant predictors of increased mean LOS, after  
179 adjusting for the effects of all significant types of medical comorbidity,  $\chi^2(38) = 1383.76$ ,  $p <$   
180  $.0001$ . Significantly, having bipolar disorder as a comorbid diagnosis was associated with 1.4  
181 additional days of stay per hospitalization on average, holding other factors constant. The effects  
182 of each type of psychiatric comorbidity were independent of each other and were similar in  
183 magnitude when tested individually, indicating no significant multicollinearity effects. Sensitivity  
184 analyses showed no impact of excluding patients who died during the study year, suggesting that  
185 the findings could not be attributed to an “end-of-life” effect.

186 ***Total hospital charges***. Consistent with our hypotheses, psychiatric comorbidities, as a  
187 group, were associated with higher total hospitalization costs,  $\chi^2(38) = 7294.32$ ,  $p < .0001$ . As  
188 shown in Table 3, the additional hospitalization costs specifically attributable to each diagnosis,  
189 ranged from \$1,8433.89 - \$7,763.47. Again, parallel analyses indicated that the effects of  
190 psychiatric comorbidity were not dependent on the multicollinearity of the variables. Sensitivity  
191 analyses indicated no effect associated with hospital charges by patients at the end of life.

192

## 193 **DISCUSSION**

194           These findings represent the first comprehensive examination of psychiatric comorbidity  
195 and hospitalizations of older patients with heart failure. We have presented evidence that the  
196 negative effects of depression on the course of heart failure<sup>19</sup> may extend to other psychiatric  
197 disturbances. In a nationally representative sample we showed that psychiatric comorbidity was  
198 prevalent in Medicare recipients hospitalized for heart failure, with depression being the most  
199 common form. All forms of psychiatric comorbidity were associated with risk of additional  
200 hospitalizations comparable to medical comorbidities within a 1-year period and that the presence  
201 of alcohol abuse, depression, bipolar disorder, or psychoses predicted longer hospitalizations. All  
202 forms of psychiatric comorbidity were associated with increased health care costs that were at least  
203 comparable to other major forms of chronic illness. For example, diabetes with chronic  
204 complications was associated with 30% increased costs; depression and bipolar disorder were  
205 associated with cost increases of 25% and 52%, respectively. Analyses reported in this paper  
206 accounted for the effects of medical comorbidities using a method developed specifically to adjust  
207 for their impact on health care utilization, costs, and illness burden.<sup>12</sup>

208           There are several potential explanations for these effects. Heavy cardiac and noncardiac  
209 comorbidities in older adults with heart failure complicates their treatment.<sup>20</sup> It may be more  
210 difficult to stabilize patients who are depressed or psychotic, and the functional disability  
211 associated with these conditions is a barrier to effective treatment.<sup>21</sup> Those with psychiatric  
212 disturbances have poorer treatment adherence and self-care.<sup>22</sup> There is also evidence that even  
213 when psychiatric disturbances are recognized and initially treated in medical contexts, the  
214 psychiatric outcomes of these patients are no better than those who had psychiatric disturbance

215 unrecognized by their medical providers.<sup>23, 24</sup> Thus, research and clinical innovation will be  
216 needed to address the challenge of treating psychiatric problems in medical settings.

217 In addition, activation of the hypothalamic-pituitary-adrenocortical axis associated with  
218 psychiatric disturbance may play a role in poorer course within and between hospitalizations,  
219 although this type of explanation has most typically been applied to the role of depression in  
220 cardiovascular outcomes.<sup>25</sup> Our data do point to effects of psychiatric comorbidity on the course of  
221 HF, specifically; patients with psychiatric comorbidity had a greater number of HF  
222 hospitalizations. Although our data cannot specifically address the mechanisms involved, this is an  
223 important avenue for future research.

224 Although our findings are similar to those of Braunstein and colleagues<sup>6</sup> we used more  
225 restrictive criteria to identify patients with chronic heart failure (i.e., at least one hospitalization  
226 with a Congestive Heart Failure DRG). This likely resulted in a more severely ill patient sample.  
227 This restriction may explain why 35.3% of our sample died during the year on which the sample is  
228 based, compared to 18% of the sample defined by Braunstein. Our findings extend earlier work by  
229 showing that other psychiatric disorders in addition to depression have important associations with  
230 increased medical care utilization and costs.

231 There were limitations resulting from the use of claims-based administrative data. There  
232 might have been positive and/or negative biases in diagnosis and medical record coders that  
233 resulted from sources such as payment incentives and stigma associated with psychiatric  
234 diagnoses.<sup>26</sup> The diagnoses in the current study could not be validated against standardized criteria.  
235 Although other studies have reported adequate sensitivity and specificity for chart based  
236 psychiatric diagnoses in mental health settings,<sup>27</sup> it is likely that diagnoses obtained from claims-  
237 based records in the current study led to lower sensitivity for psychiatric disorders. Mood



238 disorders, and potentially other psychiatric problems, are significantly underdiagnosed and  
239 undertreated in older adults in medical settings.<sup>24</sup> The rates of depression we reported are lower  
240 than in interview studies of carefully diagnosed patients hospitalized for heart failure (i.e., ranging  
241 from 20 – 37%).<sup>5, 28</sup> In addition, the phenomenon of treatment of psychiatric disorders without  
242 chart documentation of a psychiatric disorder<sup>29</sup> indicate that psychiatric difficulties in our sample  
243 could be higher than the chart-based rates suggest.

244 No information was available regarding the severity of heart failure in the sample.  
245 However, our method of replicating analyses without patients who later died gave some control  
246 over illness severity. We cannot exclude the possibility that outcomes may be worse for patients  
247 with coded comorbid psychiatric diagnoses as opposed to the presence of the conditions  
248 themselves. In addition, only longitudinal designs, with more carefully diagnosed psychiatric  
249 conditions, can clarify the complex causal relationships between psychiatric conditions and the  
250 course of heart failure hospitalizations and outcomes.

## 251 **CONCLUSION**

252 Psychiatric comorbidity is prevalent among older adults with heart failure and our findings  
253 suggest that psychiatric illness has a demonstrable impact on the utilization of acute inpatient  
254 medical care. Future research should focus on the how this effect occurs. Important changes in  
255 clinical practice with these patients may include routine screening for psychiatric disorder and  
256 increased access to pharmacological as well as cognitive-behavioral interventions, with  
257 modifications based on the needs of older adults. Future research also should be focused on how  
258 best to identify and treat psychiatric disturbance in older patients with heart failure. This line of  
259 research has promise in reducing the burden of illness on older adults with heart failure, and in  
260 reducing the high costs of treating patients with this condition.

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275 ***Steven L. Sayers, Nancy Hanrahan, Ann Kutney, Sean Clarke, Brendalis Reis, and Barbara***  
276 ***Riegel:*** These authors were involved in the concept and design of the study, as well as the  
277 interpretation of data analyses and preparation of the manuscript.

278 ***Steven L. Sayers, Nancy Hanrahan, Ann Kutney, and Sean Clarke:*** These authors were directly  
279 responsible for obtaining the data and performing the data analyses.

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290 suggestions on a previous version of the manuscript.  
291

292

293

**Table 1.** Demographic and Clinical Characteristics of Patients in the 5% Sample  
With a CHF DRG At Any Hospitalization During 1999

Characteristic			
Gender ( <i>N</i> , %)	Male	8830	41.2
	Female	12599	58.8
Race ( <i>N</i> , %)	White	18188	84.9
	Black	2301	10.7
	Other	940	4.4
Low-income ( <i>N</i> , %)		4637	21.6
Age ( <i>M</i> , <i>SD</i> )	Male	77.5	7.2
	Female	80.0	7.9
Died during 1999 ( <i>N</i> , %)		7571	35.3
# of hospitalizations ( <i>M</i> , <i>SD</i> )		2.96	2.20
# of CHF hospitalizations ( <i>M</i> , <i>SD</i> )		1.38	0.86
Avg. Length of Stay ( <i>M</i> , <i>SD</i> )		7.3	6.9
Total Charges \$ US ( <i>M</i> , <i>SD</i> )		40,048	52,916

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295

296

297

**Table 2.** Estimates of Psychiatric Comorbidity For Patients With Heart Failure DRG At Any Hospitalization During 1999 (N = 21,429)

Type of Psychiatric Disorder	N	%	95% confidence interval
Any Psychiatric Disorder	3287	15.34	
Alcohol abuse	290	1.4	1.2-1.5
Drug Abuse	122	0.6	0.5-0.7
Psychosis	534	2.5	2.3-2.7
Depression	1821	8.5	8.1-8.9
Bipolar Disorders	58	0.3	0.2-0.3
Anxiety Disorders	816	3.8	3.6-4.1
Other Psychiatric Condition	243	1.1	1.0-1.3

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299 Note: A minority of patients received more than one type of psychiatric diagnosis in 1999.

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**Table 3. Estimated Effects of Demographics, Medical and Psychiatric Comorbidities on Length of Stay, Number of Hospitalizations, and Total Hospitalization Charges For Patients With Heart Failure DRG (N = 21,429)**

Effect	Estimated		Additional Total			
	Additional Number (% change) of Hospitalizations	Estimated Additional Mean Length of Stay (% change) in Days	Parameter Estimate	<i>p</i> value	Hospitalization Charges Estimate (US Dollars)	<i>p</i> value
<b>Demographics</b>						
Age 70-79*	—	.408	0.39 (+ 9%)	<.0001	-1001.29 ( -7%)	.006
Age 80-89*	0.09 (+7%)	<.0001	1.37 (+31%)	<.0001	-1662.65 (-11%)	<.0001
Age 90+*	0.15 (+11%)	<.0001	2.30 (+51%)	<.0001	2827.77 (+19%)	<.0001
Female	-0.03 (-2%)	.016	0.39 (+ 9%)	<.0001	-813.87 ( -5%)	.001
Black race**	-0.09 (-7%)	<.0001	—	.713	—	.159
Other race**	—	.317	—	.101	3261.55 (+22%)	<.0001
Medicaid	0.08 (+6%)	<.0001	0.37 (+ 8%)	<.0001	—	.682
<b>Medical Comorbidities</b>						
Hypertension	0.39 (+30%)	<.0001	-0.30 (- 7%)	<.0001	5295.26 (+35%)	<.0001
Valvular Disease	0.21 (+16%)	<.0001	—	.455	4901.10 (+33%)	<.0001
Pulmonary Circulation Disease	0.17 (+13%)	<.0001	0.38 (+ 9%)	<.0001	2806.30 (+19%)	<.0001
Peripheral Vascular Disease	0.29 (+23%)	<.0001	0.24 (+ 5%)	.003	4320.65 (+29%)	<.0001
Paralysis	0.40 (+31%)	<.0001	1.75 (+39%)	<.0001	6613.03 (+44%)	<.0001

Other Neurological Disorders	0.22 (+17%)	<.0001	1.06 (+24%)	<.0001	3987.54 (+27%)	<.0001
Chronic Pulmonary Disease	0.30 (+23%)	<.0001	0.45 (+10%)	<.0001	5548.66 (+37%)	<.0001
Diabetes without Chronic Complications	0.16 (+12%)	<.0001	—	.08	1731.00 (+12%)	<.0001
Diabetes with Chronic Complications	0.27 (+21%)	<.0001	0.81 (+18%)	<.0001	4784.63 (+32%)	<.0001
Hypothyroidism	0.16 (+13%)	<.0001	—	.102	2390.93 (+16%)	<.0001
Renal Failure	0.22 (+17%)	<.0001	0.39 (+9%)	<.0001	3993.25 (+27%)	<.0001
Liver Disease	0.23 (+18%)	<.0001	0.53 (+12%)	.035	2506.64 (+17%)	.019
Lymphoma	0.15 (+12%)	.004	—	.772	2854.62 (+19%)	.019
Peptic Ulcer Disease and Bleeding	—	.141	—	.777	—	.723
Metastatic Cancer	0.29 (+23%)	<.0001	0.65 (+14%)	.002	3801.28 (+25%)	<.0001
Solid tumor without Metastasis	0.31 (+24%)	<.0001	—	.311	4355.15 (+29%)	<.0001
Rheumatoid arthritis/ Collagen Vascular Diseases	0.27 (+21%)	<.0001	0.71 (+16%)	<.0001	3330.07 (+22%)	<.0001
Coagulation Deficiency	0.24 (+19%)	<.0001	0.82 (+18%)	<.0001	8465.06 (+56%)	<.0001
Obesity	0.15 (+12%)	<.0001	0.41 (+9%)	.002	1896.18 (+13%)	.001
Weight Loss	0.36 (+28%)	<.0001	1.91 (+43%)	<.0001	11497.23 (+76%)	<.0001
Fluid and electrolyte Disorders	0.43 (+33%)	<.0001	0.83 (+18%)	<.0001	7381.35 (+49%)	<.0001
Chronic Blood Loss Anemia	0.31 (+24%)	<.0001	0.33 (+7%)	.021	4485.02 (+30%)	<.0001
Deficiency Anemias	0.30 (+24%)	<.0001	0.22 (+5%)	.001	4202.99 (+28%)	<.0001
Acquired Immune Deficiency Syndrome	—	.307	—	.744	—	.478
<b>Psychiatric Comorbidities</b>						
Alcohol abuse	0.21 (+16%)	<.0001	0.58 (+13%)	.026	3461.25 (+23%)	.002

Drug Abuse	0.32 (+25%)	<.0001	—	.819	3723.24 (+25%)	.031
Psychoses	0.30 (24%)	<.0001	1.06 (+24%)	<.0001	3611.95 (+24%)	<.0001
Depression	0.39 (+30%)	<.0001	0.89 (+20%)	<.0001	3815.85 (+25%)	<.0001
Bipolar Disorders	0.38 (+30%)	.001	1.43 (+32%)	.021	7763.47 (+52%)	.005
Anxiety Disorders	0.34 (+27%)	<.0001	—	.371	1843.89 (+12%)	.005
Other Psychiatric Condition	0.37 (+29%)	<.0001	—	.702	3694.33 (+25%)	.003

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305 Notes:

306 Entries in Table 3 were calculated from GLM models and presented as actual hospitalizations, average LOS  
307 in days, and total charges for ease of interpretation following the methods of Zhou, Stroupe and  
308 Tierney<sup>30</sup>. For parameters that were statistically significant, estimates represent the increased/decreased  
309 utilization associated with the characteristic, in relation to the intercept value. In addition, the percent  
310 increase in the estimate relative to the intercept value is also presented. The intercept values for the  
311 outcomes in the table were as follows: 1.28 hospitalizations, 4.47 days of length of stay, and total charges of  
312 \$15,037.21.

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314 \* Age 65-69 is reference category.

315 \*\*White race is reference category.

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