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Depression and Gender Effects on Healthcare Costs of Heart Failure: Examining Rural-Urban Differences

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Abstract

Objectives: Depression and anxiety are frequently observed in heart failure (HF) patients. However, effect of such factors on hospital costs of HF, and whether such costs vary by urbanization and gender remain poorly understood. This analysis delineates the prevalence of depression among HF patients and estimates depression effects on hospital costs of patients from rural and urban communities.

Methods: We examined the 2010 files of California hospital discharge data system (HDDS) on patients (aged 20+) with a primary diagnosis of HF (ICD-9 codes 402, 404, 428) along with their demographics, depression diagnosis, hospital costs, and co-morbid conditions. The HF sample (n = 62,685; average age 73 (SD=14.8), females - 49.3%), included 15.5% patients from rural counties. Differences in hospital costs were evaluated for sub-groups: (i) by urbanity and gender, and (ii) HF with depression (HF+D) versus HF without depression (HF^{ND}).

Results: Nearly 21% of HF patients had depression; depression was higher in rural than urban patients (22.6% vs. 20.2%, p < .001), and higher among females than males (25% vs. 16.3%, p < .001). Further, HF, which existed among 26.7% of all patients, was higher among urban than rural patients (28.3% vs. 26.3%, p < .001), and higher among males than females (27.5% vs. 26.0%, p < .001). HF+D patients had 3+ co-morbidities (higher among males and urban than females and rural patients). Overall, healthcare costs were higher among urban, males and those depressed (HF^{+D}) compared to non-depressed, females, and rural patients. Nearly 21% of HF patients had depression; depression was higher in rural than urban patients (22.6% vs. 20.2%, p < .001), and higher among females than males (25% vs. 16.3%, p < .001). Further, HF, which existed among 26.7% of all patients, was higher among urban than rural patients (28.3% vs. 26.3%, p < .001), and higher among males than females (27.5% vs. 26.0%, p < .001). HF+D patients had 3+ co-morbidities (higher among males and urban than females and rural patients). Overall, healthcare costs were higher among urban, males and those depressed (HF+D) compared to non-depressed, females, and rural patients.

Conclusion: Depression, urbanization, and gender are all associated with higher hospital costs. The higher costs among males and urban patients reflect higher burden of co-morbidities such as hypertension and diabetes, that call for widespread dissemination, adoption, and implementation of proven interventions to control them. Since majority of HF+D were females (60%), these data are consistent with the hypothesis that considerable cost savings might be attained if depression is treated along with heart failure. Analytic epidemiologic and clinical studies would be needed to confirm or deny this hypothesis.

Keywords: *Depression; Rural; Hospital Cost; Heart Failure; Gender*

Background

According to US Centers for Disease Control and Prevention (CDC), depression affects 7.6 million American adults, and 43% of whom report that it has serious effects on their work and activities of daily living [1]. Similarly, heart failure (HF) is a major health problem that impacts more than 6 million adults [2]. It is estimated that by 2030, an additional 3 million will be affected by HF [3]. At age 40, the lifetime risk of developing HF is 1 in 9 (11%) for males and 1 in 6 (17%) for females [4,5]. Fifty percent of patients die within 5 years of HF diagnosis [6].

Approximately 25% of patients with heart failure and 50% of patients with advanced heart failure experience depression [7]. HF not only decreases the quality of life, but it also contributes to increasing levels of depression. Moreover, some evidence suggests that depression increases the risk of heart failure [8]. For example, a Norwegian study found that people with mild depression were 5% more likely to develop HF, while those with moderate to severe depression had 40% risk of HF [8]. Another study reported that patients with major depression transition faster to HF from a healthy state or a state in which they have only one risk factor (e.g. hypertension) than patients without depression [9]. This significant interplay contributes to HF being one of the leading causes of hospital admissions among the elderly, and as such it represents a heavy healthcare cost burden. According to American Heart Association (AHA), as the elderly make up an increasing proportion of the population, both the direct and indirect healthcare costs of HF are expected to increase more than two-fold; from $31 billion in 2012 to $70 billion in 2030 [10].

Risk factors associated with HF vary considerably. While low health literacy and lower social class position dominate the non-clinical risk factors [11,12], most cited clinical risk factors of HF include diabetes mellitus (DM) [13-16], heart attacks MI) [17], obstructive sleep apnea (OSA) [18,19], serum albumin level [20], atrial fibrillation (AFib) [21,22], chronic kidney disease (CKD) [23,24], chronic obstructive pulmonary disease (COPD) [25,26], depression [27-33], and hypertension (HTN). In fact, hypertension, which has been observed in more than 75% of all HF patients, doubles the lifetime risk for HF for individuals with blood pressure (BP) > 160/90 mm Hg compared to BP < 140/80 mm Hg [34,35].

The effects of these risk factors and depression on healthcare cost of HF and its variation by sub-groups of patients is an important gap in current knowledge. A better understanding of these factors could provide clues to better control of costs. Therefore, in this analysis, we examine three issues by urbanization and gender: (i) prevalence of depression and HF; (ii) variations in risk factors of HF, and (iii) variation in depression effects on hospital cost.

Methods

Sample

We examined 2010 hospital discharge data system (HDDS) file obtained from the California's Office of State Planning and Development (OSHPD) on patients (aged 20+) discharged with a primary diagnosis of HF (ICD-9 codes 402,404,428; n = 62,685; mean age 73, SD =14.8; females 43%) along with their demographics, number of admission, days in hospital, charges/costs ($) for each discharge, secondary diagnoses (summed as co-morbidities), and the diagnoses of depression and anxiety. Since 48% to 91% of symptoms overlap between depression and anxiety [36,37], we combined them as a single variable of depression for our analyses. Finally, according to Bureau of Census, California has 13% of its population classified as rural and according to a California State document entitled "Health of Rural and Urban California Counties", we classified California counties as rural or urban per methodology described in that document.

We computed two indices of co-morbidities: (1) one index composed of a simple count of all secondary diagnoses that were identified by ICD-9-CM codes for each patient, and (2) a Charlson [38] Index of severity of co-morbidity whereby higher index scores stood for high severity of the disease. Further, two types of hospital costs were developed: (i) costs for HF alone (HF Cost in USD) when a patient was discharged with a primary diagnosis of HF, and (ii) total hospital cost for the entire year 2010 (Total Cost in USD), that is, when the same HF patient was discharged with other diagnoses during 2010.

Statistical analysis

Differences in the prevalence of HF risk factors by urbanity/gender were evaluated with the Pearson Chi Square and the Fishers Exact Tests. Multiple logistic regression models were used to examine the likelihood of HF association with risk factors, and cost differences were examined with ANOVA.

Results

Prevalence of Depression and HF

One-fifth of HF patients (20.6%) were diagnosed with depression, and depression was more prevalent among rural patients compared to urban patients (22.6% vs. 20.2%, $p < .001$). Further, depression was higher among females than males (25.0% vs. 16.3%, $p < .000$), regardless of whether they were from rural (F:M; 24% vs. 16%, $p < .001$) or urban communities (F:M; 28% vs. 18%, $p < .001$). Similarly, 26.7% of patients in 2010 were discharged with a primary diagnosis of HF; HF prevalence was higher among urban compared to rural patients (28.3% vs. 26.3%, $p < .001$). Further, HF was more prevalent among males than females (27.5% vs. 26.0%, $p < .001$), both among rural (M:F; 26.5% vs. 24.9%, $p < .001$) and urban patients (M:F; 27.7% vs. 26.2%, $p < .001$).

HF Risk Factors

The results of multiple logistic regression analyses (Table 1, odds ratios, col. 3) revealed that of 9 factors examined, stroke was unrelated to HF while remaining eight (8) were associated with HF (p. < .001) including hypertension (HTN; OR = 1.42), diabetes mellitus (DM, OR = 1.08), high cholesterol (hyperlipidemia; OR = 1.20), coronary heart disease (CHD; OR = 1.22), chronic kidney disease (CKD; OR = 1.66), cardiac arrhythmia (CA; OR = 1.40), chronic obstructive pulmonary disease (COPD; OR = 1.24), and depression (OR = 1.04). Six of these risk factors were common to both rural and urban patients except for depression and diabetes mellitus which while unrelated to HF among rural patients (see col. 4), they were related to HF among urban males (OR = 1.06, each for depression and DM, col. 8).

Factors	No HF	All HF	HF OR/CI	Rural All	Rur M	Rur F	Urban All	Urb M	Urb F	HF^{+D} All	HF^{+D} Rur Male	HF^{+D} Rur F	HF^{+D} Urb Male	HF^{+D} Urb F
N = - >	1710	62685	62685	9746	5037	4709	52939	26719	26220	12908	879	1323	4308	6398
Col - >	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Dep %	19.0	20.6*	1.04*/ 1.01 - 1.06	1.04/ .98 - 1.11	.99/ ,91 - 1.1	1.10+/ 1.02 - 1.19	104*/ 1.01 - 1.06	1.06*/ 1.02 - 1.10	1.02/ .99 - 1.05	- - - -	- - - -	-----	-----	-----
HTN %	79	87*	1.42*/ 1.38 - 1.45	1.42*/ 1.31 - 1.49	1.34*/ 1.23 - .46	1.49*/ 1.36 - 1.65	1.42*/ 1.37 - 1.46	1.39*/ 1.33 - 1.45	1.42*/ 1.36 - 1.48	1.47*/ 1.37 - 1.57	1.36+/ 1.07 - 1.72	1.33*/ 1.09 - 1.71	1.53*/ 1.35 - 1.73	1.44*/ 1.30 - 1.59
DM %	41	48*	1.08*/ 1.05 - 1.10	1.02/ 97 - - 1.1	1.0/ ,94 - 1.1	1.06/ .98 - 1.14	1.09*/ 1.06 - 1.11	1.06*/ 1.03 - 1.09	1.13*/ 1.09 - 1.20	1.15*/ 1.09 - 1.19	1.01/ .86 - 1.20	1.11/ .85 - 1.19	1.11*/ 1.03 - 1.20	1.21*/ 1.14 - 1.29
Chol %	8	11*	`1.20*/ 1.16 - 1.24	1.15*/ 1.05 - 1.24	1.10/ .98 - 1.23	1.22*/ 1.07 - 1.37	1.21*/ 1.17 - 1.24	1.19*/ 1,14 - 1.22	1.25*/ 1.18 - 1.30	1.25*/ 1.17 - 1.32	1.14/ .88 - 1.47	1.35*/ .88 - 1.47	1.20*/ 1.07 - 1.35	1.28*/ 1.16 - 1.40
CHD %	52	60*	1.22*/ 1.19 - 1.24	1.20*/ 1.15 - 1.26	1.18*/ 1.10 - .26	1.24*/ 1.16 - 1.33	1.24*/ 1.21 - 1.26	1.24*/ 1.20 - 1.28	1.25*/ 1.21 - 1.29	1.42*/ 1.35 - 1.48	1.34*/ 1.09 - 1.67	1.58*/ *1.45 - 1.71	1.58*/ 1.45 - 1.71	1.38*/ 1.29 - 1.47
CKD %	36	51*	1.66*/ 1.63 - 1.69	1.79*/ 1.69 - 1.87	1.82*/ 1.71 - .96	1.78*/ 1.65 - 1.90	164*/ 1.60 - 1.67	1,65*/ 1.60 - 1.69	1.66*/ 1.61 - 1.71	1.93*/ 1.84 - 2.01	2.35*/ 1.98 - 2.78	1.97*/ 1.71 - 2.26	2.03*/ 1.87 - 2.20	1.85*/ 1.74 - 1.96
CA %	48	57*	140*/ 1.37 - 1.43	1.48*/ 1.49 - 1.54	1.45*/ 1.35 - .54	1.52*/ 1.41 - 1.62	1.39*/ 1.36 - 1.42	1.36*/ 1.32 - 1.40	1.42*/ 1.37 - 1.46	1.70*/ 1.62 - 1.77	1.63*'/ 1.38 - 1.93	1.86*/ 1.62 - 2.13	1.64*/ 1.52 - 1.78	1.71*/ 1.61 - 1.81
COPD %	30	36*	1.24*/ 1.22 - 1.27	1.19*/ 1.14 - 1.25	1.22*/ 1.14 - .31	1.17/ 1.09 - 1.26	1.25*/ 1.23 - 1.28	1.27*/ 1.23 - 1.31	1.26*/ 1.22 - 1.29	1.28*/ 1.23 - 1.34	1.34*/ 1.14 - 1.58	1.16+/ 1.01 - 1.32	1.35*/ 1.25 - 1.45	1.27*/ 1.20 - 1.35
Stroke %	15*	12	.69/.67 - .71	.71/.66 - .76	.69/,62 - .77	.72/ .65 - .80	.69/.67 - .71	.68/.64 - .71	.70/.67 - .73	.83/.78 - .87	.81/ .64 - 1.01	.91/ .76 - 1.09	.80/.73 - .89	.84/ .77 - .91

Table 1: Odd ratios of CVD factors associated with Heart Failure by urbanity and gender sub - groups, 2010.

+ and * stand for being significant at p < .05 or p < .001 level; OR/CI: Odd ratios/CI is 95% confidence interval; Dep%: Percentage of patients with depression; HTN%: % of hypertension; DM: % of diabetes mellitus; Chol: % with hyperlipidemia; CHD: % with coronary heart disease; CKD: % with chronic kidney disease; CA: % with cardiac arrhythmia; COPD: % with chronic obstructive pulmonary disease; OR/CI: Odd ration/95% confidence interval; Rur M: Rural males' Rur F: Rural females; Urb M: Urban males; Urb F: Urban females; HF^{+D} All: All HF patients with depression; HF^{ND}: Patients without depression.

Factors	No-HF	All HF	Rural All	Rural Male	Rural Fem	Urban All	Urban Male	Urban Fem	HF^{ND}	HF^{+D} All	HF^{+D} Rural Male	HF^{+D} Rural Fem	HF^{+D} Urban Male	HF^{+D} Urban Fem
N = ->	171780	62,685	9746	5037	4709	52939	26719	26220	49777	12908	879	1323	4308	6398
Col.-->	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Age	73	73	73	71	76	73	70	76	73	72	70	74	69	74
#Comorb	3.3	3.8	3.8	3.8	3.7	3.8	3.9*	3.8	3.5	5.0*	5.2*	4.8	5.2	4.9
Charlson	---	3.6	3.6	3.6	3.5	3.6	3.7*	3.5	3.5	3.9*	4.1*	3.7	4.1	3.8
# Adm.	1.4	2.3	2.28	2.3	2.3	2.33+	2.4*	2.3	2.1	3.2*	3.4	3.0	3..5	3.1
LOS	12.1	13.9	13.2	12.8	13.6	14.1*	13.8	14.3	11.8	23.0*	17.9*	12.9	24.1	21.6
HF Cost $	---	77,417	73,163	76998*	69061	78,201	84802*	71474	73,667	91,880*	105090*	83142	109990	79680
Total cost	130130	150,500*	145,780	152150+	138960	151,370	159160*	143420	133,640	215,500*	240290*	193180	246100	196080
SD	25329	25112	26477	29624	22615	24913	27348	22131	29951	31986	36493	27654-	37922	27268

Table 2: Hospital costs of heart failure patients by urbanity, gender and depression sub-groups.

+ and * stand for differences between two adjacent columns (like col. 1 and 2 or 4-5, or 10 - 11) are significant at p < .01 and p < .001 levels respectively;

Comorb: Umber of comorbidities' Charlson: Charlson Index of illness severity; # Adm: Number of hospital admissions; LOS: Length of hospital stay in days; HF Cost $: HF cost alone in USD for year 2010' Total cost $: Total cost in USD for year 2010 including HF cost; SD: Standard Deviation.

Similar patterns of relationships emerged when we compared depressed patients (HF^{+D}) with non-depressed (HF^{ND}). Here all six (6) factors were significantly associated with HF (see col. 10) whereby depressed patients (HF^{+D}) had higher prevalence of hypertension, diabetes mellitus, coronary heart disease, chronic kidney disease, cardiac arrhythmia, and chronic obstructive pulmonary disease. These significant relationships suggest that HF^{+D} patients were the sickest as a sub-group of patients.

Variation in Healthcare Costs

Table 2 shows the average hospital cost of HF was $77,417 (SD 14,843) per patient, and the total costs for HF in 2010 was $20,370 more compared to non-HF patients ($150,500 vs. $130,130, $p < .001$, col. 1 - 2). Further, the average costs for urban HF patients were nearly $6,000 more compared to rural patients (see cols. 3 and 6; U:R; HF alone:$78,201 vs. $73,163, $p < .001$; total cost: $151,370 vs. $145,780, $p < .01$). It may be pointed out that male costs in both rural and urban areas (see Cols; 4 - 5, 7 - 8) were higher compared to their female peers (M:F; HF cost: $76,998 vs. $69,061; total cost: $152,150 vs. $138,960).

When depression was added to the cost equation, the cost for depressed patients (HF^{+D}) increased by 46% compared to non-depressed (HF^{ND}) patients ($215,500 vs. $133,640, $p < .001$, cols, 9 - 10). Further, costs for depressed males remained higher compared to depressed females regardless of urbanity (see cols, 11 - 12 and 13 - 14). These higher costs occurred partly due to higher prevalence of co-morbidities, re-admissions, and longer hospital stay (Table 2, cols. 2-14). Finally, it may be noted that nearly 50% of the Total costs in 2010 were due to costs involved with the treatment of HF admission itself.

Discussion

California is a highly urbanized state where only 13% of the population is classified as rural. The state has 341 hospitals and only 34 (9.9%) are in rural counties. Health services in rural areas are also provided by 280 subsidized medical centers that are mostly managed by physician assistants and nurses. The rural population is characterized by both low health literacy and low percentage of those with health insurance [39,40], fewer mental health services, and fewer physicians. All these factors result in poor access to health care services in rural communities [41,42].

While rural residents suffer from the same illnesses as do the urban residents, their acute and complex cases are usually referred/transferred to larger and more equipped urban facilities [42]. Within this context, it may be noted that in our sample only 16% of HF patients were from rural counties and their healthcare costs were comparable to urban costs (urban: rural HF cost: $78,201 vs. $73,163; total 2010 cost: $151,370 vs. $145,780) because some complex rural cases may have been treated by experts at urban facilities. Illness severity data were not available to examine this possibility. However, these HF healthcare costs in our data set appear to be similar to the HF costs reported by others [43,44].

Similar pattern of high cost existed for depressed and male patients who required more treatment. The higher costs among these depressed groups (HF+D) reflect the costs of treating depression along with more than three (3) co-morbidities, some of these co-morbidities requiring special treatment that may have added to both longer hospitalization and higher costs.

We noted higher hospital costs for males in our data and they may exist due to various factors. For instance, males are known to seek help late in the progression of their illness while females may seek help early [45-50]. This late help seeking among males not only complicate medical problems but may also add to the cost. Females, on the other hand, seek help at the very start of the illness and don't let problem become more complex and costly [43-45]. Such gender differences in costs appear to be reflected in our study where male costs were always higher (M:F total rural cost: $152,150 vs. $138,960; total urban cost: $159,160 vs. $143,420; Table 2, cols. 4-5,7-8).

Similar cost differences by gender emerged among depressed patients (HF^{+D}). While the depressed group (HF^{+D}) had more women than men (60% vs. 40%), the total healthcare cost among depressed males remained higher regardless of urbanity (M:F; total rural cost; $240,290 vs. $193,270; total urban cost; $246,100 vs. $196,080, Table 2, cols 13 - 14). Given the cost differential and the fact that depression affected 20% of our patients, these data are consistent with the hypothesis that considerable costs savings might be attainable if all patients were screened and treated for depression appropriately. Analytic epidemiologic and clinical research would be needed to confirm or deny this hypothesis.

Finally, we noted that these HF patients had numerous chronic conditions (such as hypertension, diabetes, and chronic kidney disease), that were highly prevalent and associated with HF among both rural and urban patients. The high prevalence of these medical disorders is consistent with the hypothesis that effective preventive programs (both primary and secondary) and optimal therapy need to be implemented to help reduce such co-morbidities. Such interventions may include improved coordination of community-based resources for HF patients with complex co-existing conditions and reduce the need for hospitalization especially in underserved communities. Again, analytic epidemiologic and clinical research would be needed to confirm or deny this hypothesis. If confirmed, one outcome might also be better control of healthcare costs.

Limitations

The hospital discharge data (HDDS) used for this article are administrative files and they do not provide any clinical data about the patients' severity of illness or treatment modalities used or reimbursements amounts received by the hospital for the services provided. The reported costs are hospital charges submitted to insurance companies for payment. The data are cross-sectional and follow-up of patients beyond one year is not possible as patients' ID numbers change each year. Despite these limitations, the large number of cases in the sample provide valuable clues from policy and programming perspectives.

Conclusion

While rural and urban patients share similar risk factors of HF, depression increases their healthcare costs regardless of urbanization. Epidemiologic studies are needed to examine whether urban higher hospitalization costs occur due to severity of co-morbidities, or other factors.

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