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Research Article

Examining Effects of Depression on Hospital Cost of Breast Cancer among Women

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Abstract

Objective: While depression occurs in 20-50% in breast cancer (BC) patients, the effect of depression on hospital costs for BC remains unknown. In this paper we describe: (i) the prevalence of BC, depression, and associated risk factors among women discharged from hospitals in Tennessee; and (ii) the effects of depression on BC hospital costs.

Methods: We extracted cross-sectional data from the 2008 Tennessee Hospital Discharge Data System (HDDS). Breast cancer and depression were identified from the patient's ICD-9 codes. The BC sample (n = 2,522) had an average age of 63 years and was mostly white (83%). We computed age-adjusted BC prevalence per CDC methodology, and compared the hospital costs for BC patients with depression (BC^{+D}) and without depression (BC^{ND}).

Results: The overall age-adjusted BC prevalence at discharge was 52.5 per 100,000 populations. Prevalence was higher among whites than blacks (43.3 vs. 9.2, $p < 0.001$). In our cohort, 23% of BC patients were depressed. The depression rates were higher among whites than blacks (25% vs. 14%, $p < 0.01$). The hospital costs for BC were 26% higher compared to non-BC patients ($46,609 vs. $35,974, $p < 0.001$). The hospital costs for depressed patients (BC^{+D}) were 44% higher than BC^{ND} patients ($64,439 vs. $41,344, $p < 0.001$). Higher hospital costs were found among both blacks and whites with a co-prevalence of depression (BC^{+D}) compared to non-depressed (BC^{ND}) peers.

Conclusion: Depression was associated with higher hospital costs among women with BC, regardless of race. These descriptive data are consistent with the hypothesis that screening and treating depression among BC patients before hospitalization might attain considerable cost savings. Analytic epidemiologic study would be required to develop appropriate treatment regimens for BC patients with depression.

Keywords: *Depression; Breast Cancer; Race; Hospital Cost*

Background

According to the United States (US) Centers for Disease control and Prevention (CDC), the incidence of breast cancer (BC) has declined in most of the states in US States as well as across various racial groups [1,2]. Importantly, the US BC mortality has generally declined except among black women. Black mortality rates remain higher and 5-year survival rates remain lower compared to white women [2].

Breast Cancer Risk Factors

Cardiovascular diseases (CVD) and cancers comprise 65% of all medically-related deaths in the US [3]. There is evidence of a significant etiological overlap between breast cancer and CVD risk factors such as hypertension [4], diabetes mellitus [5,6], coronary heart disease [7], chronic kidney disease [8], stroke [9] and atrial fibrillation resulting from chemo/radiation therapy [10,11]. Further, chronic obstructive pulmonary disease, is also related to BC through smoking induced inflammation [12-15]. Additionally, a positive correlation has been identified between BC and depression [16-18]. Literature evidence also suggests a causal-link of smoking with breast cancer [19,20] and depression [21,22]. Specifically, increasing levels of smoking are associated with increasing severity of depression, and depressed smokers are less likely to quit smoking than non-depressed smokers [21,22]. However, a precise interdependency between smoking, CVD, BC and depression is yet to be established.

Breast Cancer Cost

The average hospital cost for BC is difficult to estimate because of numerous factors including tumor size, tumor stage, treatment modalities (e.g. surgery, chemo/radiation/hormonal therapy), and other factors including health insurance. The average cost of initial breast cancer treatment for older women (age 65+ years) was estimated at $23,078 with an increment of $2,207 for each subsequent treatment [23]. Among younger women, however, the cost per year has varied from $41,686 [24] to $42,401 (for patients age 61 - 65 years) [25] and up to $85,772 among younger women (age < 55 years) [26] for all combined tumor stages. Higher costs among younger women appear to be related to tumor stage and increasing preference for mastectomy [27]. However, these hospital costs may further increase when accounting for depression among BC patients. Evidence suggests that depression may add more than 30% to the hospital costs [28-30].

Given the importance of breast cancer as a major cause of morbidity and mortality among women, along with inter-dependency between factors associated with CVD, cancer and depression, and especially the sparse literature evidence to illustrate the possible effects of depression on BC hospital costs, our paper examines two related issues among women discharged from the hospital with BC: (i) the prevalence of depression and BC along with CVD risk factors associated with BC; and (ii) a comparison of hospital costs among depressed BC patients (BC^{+D}) and non-depressed BC patients (BC^{ND}).

Methods

Sample: We examined administrative files of Tennessee Hospital Discharge Data System (HDDS) for women (n = 248,837) discharged in 2008. We identified female patients with the following ICD-9 codes: a diagnosis of BC - ICD-9 code, 174; 296: episodic mood disorders; 311: depressive disorders; codes 657 for mood disorders, and codes 300.1 and 300.2 for anxiety disorders. As mood disorders and anxiety are difficult to separate based on clinical classification, we have combined both into the depression classification [31,32]. Approximately 10% of the discharged patients were diagnosed with BC. The BC sample (n = 2,522) included whites (83%) and African Americans (blacks; 17%). Their average age was 63 years (Standard Deviation (SD) = 14.4). Overall, 20% of patients were under the age of 50 years (including 29% of blacks and 19% of whites). All BC patients had at least two medical co-morbidities. It is noted that these administrative files do not provide clinical data pertaining to tumor size/stage or severity of clinical condition, test results, or medications administered.

Data Characteristics and Statistical Analysis: HDDS data are administrative files that provide patients' basic demographics (e.g. sex, age, race) along with the primary and secondary diagnoses given by the attending physicians. Since 48% to 91% of symptoms overlap between depression and anxiety [31], we combined them as a single variable [32] ("Depression") for our analyses.

A simple sum of all secondary diagnoses for each patient was treated as the patient's total number of co-morbidities. Additionally, two costs were computed: (i) BC Cost for 1st admission, that is, when a patient was first discharged with a diagnosis of BC; and (ii) total hospital costs, including the cost of all discharges for the same BC patient for the entire year of 2008. In our statistical analysis, chi-square tests were conducted to assess the univariate association between presence of depression and an individual's characteristics. We performed t-tests to assess significant differences in expenditures in individuals with (BC^{+D}) and without depression (BC^{ND}).

Age-adjusted BC rates per 100,000 adults (using 2010 Tennessee population) were developed per CDC methodology [33]. Differences in the prevalence of BC risk factors were examined with multivariate logistic regression models along with the Pearson χ^2 and the Fisher's Exact Tests. Cost differences were evaluated with ANOVA. All analyses were performed using SPSS21.

Results

Breast cancer and depression prevalence

We first determined the prevalence of depression in BC. As shown in table 1 the overall BC prevalence at the time of hospital discharge was 52.5 per 100,000 population. BC prevalence was higher among white women compared to black women (43.3 per 100,000 vs. 9.2 per 100,000, $p < 0.01$). Further, nearly one-fourth (23%) of BC patients were diagnosed with depression, and depression diagnoses were higher ($p < 0.01$) among whites than blacks (25% vs. 14% respectively). Finally, more than one-tenth of BC patients (13%) had a smoking history, with smoking being more common among whites than blacks (Table 1, cols. 5 and 6).

Variable	All Non-BC	Breast Cancer Patients					Breast Cancer and Depression			
		Total	OR	95% CI	White	Black	BC^{ND}	BC^{+D}	OR	95% CI
Cols. →	1	2	3	4	5	6	7	8	9	10
N →	246,315	2,522	-----	-----	2,077	445	1,947	575	-----	-----
Age	54	63	59	64	62	58	62	63	-----	-----
BC Rate	-----	52.5	-----	-----	43.3	9.2	-----	-----	-----	-----
Dep. %	19	23+	1.04	0.94 - 1.14	25*	14	-----	-----	-----	-----
HTN %	48	55*	1.51*	138 - 1.65	52	69*	52	66*	1.13	0.94 - 1.37
DM %	20	23+	1.05	0.94 - 1.16	21	31*	21	27*	0.99	0.82 - 1.21
Chol %	7	8	1.18+	1.02 - 1.35	9	7	8	9	0.85	0.64 - 1.04
CHD %	18*	14	0.69	0.61 - 0.78	14	16	12	20*	0.83	0.55 - 1.27
CKD %	8	7	0.78	0.66 - 0.93	5	11*	5	10*	1.09	0.84 - 1.44
MI %	3	1	0.50	0.34 - 0.72	1	2	1	2	0.58	0.30 - 1.11
Stroke %	8	6	0.63	0.53 - 0.75	5	6	5	9*	0.77	0.57 - 1.04
AFib %	15	15	1.04	0.93 - 1.18	15	15	14	18+	0.95	0.78 - 1.18
COPD %	16+	14	0.75	0.66 - 0.85	15+	11	11	23*	0.83	0.61 - 0.91
Smoke Hist. %	7	13*	1.97*	1.74 - 2.22	13*	11	12	16+	1.59*	1.26 - 2.01
Obesity %	0.4	0.4	1.01	0.56 - 1.84	0.4	0.4	0.4	0.5	0.72	0.23 - 0.75
#Comrbs	1.72	2.78	-----	-----	2.7	2.9	2.4	4.0	---	---

Table 1: *Breast Cancer (BC) Rates and Clinical Characteristics of Female Patients by Race. + and * refer to percentage differences and OR significant at $p < .01$ and $p < 0.001$ respectively; BCND: Breast Cancer Non - Depressed; BC+D: Breast Cancer with Depression; HTN: Hypertension; DM: Diabetes Mellitus; Chol: High Cholesterol; CHD: Coronary Heart Disease; CKD: Chronic Kidney Disease; MI: Myocardial Infarction; AFib: Atrial Fibrillation; COPD: Chronic Obstructive Pulmonary Disease; Smoke Hist.: Patient had a smoking History; # Comorbs: Number of Co - Morbid Medical Conditions*

Risk factors in BC

As shown in table 1 (cols. 1 and 2), BC patients had a higher prevalence ($p < 0.001$) relative to non-BC patients OF hypertension (55% vs. 48%), diabetes (23% vs. 20%), depression (23% vs. 19%), and smoking history (13% vs. 7%). In regression analyses, however, the following emerged as having a statistically significant, independent association with BC (cols. 3-4): hypertension (OR = 1.51, CI = 1.38 - 1.65), hypercholesterolemia (OR = 1.18, CI = 1.02 - 1.35), and smoking history (OR = 1.97, CI = 1.74 - 2.22). These data suggest that CVD risk factors have equivalent prevalence in BC patients.

Effect of depression on hospital costs

We next determined the impact of depression on BC health care expenditure. The average first-admission costs (Table 2, cols 1 and 2) were higher for BC than non-BC patients ($25,038 vs. $20,744, $p < 0.001$). Similarly, the 12-month hospital cost for BC patients (Table 2, cols. 1 and 2) were nearly 26% higher compared to non-BC patients ($46,609 vs. $35,974, $p < .001$). These higher total costs for BC patients were due, in part, to a greater number of co-morbidities (2.78 vs. 1.72) and re-admissions (1.76 vs. 1.49; Table 2, cols. 1-2), as well as longer hospitalization (8.8 days vs. 7.1 days).

With respect to depression, hospital costs for BC^{+D} (Table 2, cols. 5-6) were nearly 44% higher than non-depressed (BC^{ND}) patients ($64,439 vs. $41,344, $p < 0.001$). Further, the higher cost for BC^{+D} remained intact for both blacks and whites (BC+D) relative to non-depressed (BC^{ND}) peers (Table 2, cols. 7-10) Among depressed BC patients, the cost for depressed blacks was 46% higher than that for depressed whites ($96,653 vs. $60,405), largely due to more re-admissions (2.9 vs. 2.3, $p < 0.01$) and longer hospitalization (21.5 days vs. 12.1 days, $p < 0.001$).

Cost Factors	All	Breast Cancer Patients					Black		White	
	Non-BC	All	White	Black	BC^{+D}	BC^{ND}	BC^{+D}	BC^{ND}	BC^{+D}	BC^{ND}
Col.-->	1	2	3	4	5	6	7	8	9	10
N→	24,6315	2,522	2,077	445	575	1,947	64	381	511	1,566
Age	54	63	64	45	62	63	59	59	63	64
#Comorb.	1.72	2.78*	2.7	2.9*	4.0*	2.4	4.5*	2.7	3.9*	1.2
#Adm.	1.49	1.76*	1.7	1.9+	2.4*	1.6	2.9*	1.7	2.3*	1.5
Hosp.Days	7.1	8.8*	8.2	11.8*	13.2*	7.5	21.5*	10.1	12.1*	6.9
1st Adm. $	20,744	25,038*	25,140	31,024	26,153	24,841	33,031	31,496	25,492	23,350
Total 12-month $	35,974	46,609*	43,459	61,315*	64,439*	41,344	96,653*	55,379	60,405*	37,929

Table 2: *Average Hospital Cost of Breast Cancer (BC) by Race and Depression in 2008.*

**: Differences between two adjacent columns (e.g., 1 vs. 2) are significant at $p < 0.001$; BC^{ND}: Breast Cancer Non-Depressed; BC^{+D}: Breast Cancer with Depression; #Comob: Number of Comorbidities; #Adms: Number of Admissions; Hosp. Days: Number of Hospital Days; BC cost 1st Adm.: Cost of BC Patients for 1st Admission; Total 12-month cost $: Total Hospital Cost for 2008 in Dollars. Percentage value between 2 values (e.g., $46,609 and $35,974: 25.76%) were calculated with percentage calculator giving its formula: ((V1 – V2)/(V1 +V2/2))*100.*

These cost differences between blacks and whites persisted when we analyzed the first admission for breast cancer in three age categories: 20 - 50 years, 51 - 64 years, and 65+ years. In each age group, the cost for blacks was higher ($p < 0.001$) compared to white peers ($33,936 vs. $31,430 at 20-50 years; $31,988 vs. $24,247 at 51 - 64 years, and $28,925 vs. $19,723 at 65+ years). These higher costs among blacks were associated with the presence of greater numbers of comorbid conditions along with longer hospitalization. Variations in tumor grade and stage may be contributing to these racial cost differences but, as previously noted, such tumor information at diagnosis was not available in these data.

Discussion

BC patients discharged from hospitals had a higher prevalence of hypertension, hypercholesterolemia, and a history of smoking compared to non-BC patients. These co-morbidities are similar to those previously reported [4,6,17,18]. However, it cannot be determined from our data whether these conditions existed before or after the diagnosis of BC. Despite this limitation, our data point to a possible link between BC and the combined effects of such factors and increased hospitalization costs. Given the age of our BC patients (63 years) and

the fact that more than one-tenth (13%) had a smoking history, these descriptive data are consistent with the hypothesis that smoking may contribute to both coronary heart disease and BC. Analytic epidemiologic studies designed a priori to do so would be required to accept or deny this hypothesis.

The prevalence of depression in our study sample was higher among whites than blacks. Previous research among women with newly diagnosed breast cancer has suggested that certain behaviors of black women may be associated with lower levels of self-reported distress [34]. The overall prevalence of depression in our data (23%) is higher than the prevalence of depression (8.5%) in elderly prostate cancer patients from SEER-Cancer registries [35]. These differences are plausible because depression may vary by age, gender, and cancer type. Depression prevalence was reported to be as high as 38% in pancreatic cancer patients, 14% - 40% in breast cancer patients, and 4.7% - 33% in lung cancer patients [36]. The current findings are consistent with the hypothesis that depression screening in breast cancer patients and the treatment of depression before it becomes severe may be useful. The United States Preventive Services Task Force [37] and others [38] recommend depression screening for the general adult population so long as there are adequate systems in place to ensure accurate diagnosis, effective treatment and appropriate follow-up. Because there is much uncertainty about how to treat depression in patients with cancer [39], data from well-designed, randomized clinical trials among patients with breast cancer is needed, not only to determine the relative effectiveness of various treatment approaches, but also to determine the effectiveness of screening within this special population. Further, there is limited evidence for the effectiveness of pharmacological and psychosocial interventions in the treatment of cancer patients with depressive disorders, and no evidence for the superiority of one treatment modality over another. Based on evidence from the general population and other medically ill populations, combined approaches to the treatment of depression may be the most effective [40,41]. Further research is necessary in cancer patients to determine the relative effectiveness of psychosocial, pharmacological, and combined treatments.

The average BC cost in our data was $46,609 and is similar to previous estimates of $41,686 [24] and $42,410 [25]. Additionally, among these patients, hospital costs increased by 44% for depressed (BC^{+D}) patients. This cost increment associated with depression is also similar to previous reports [28-30]. In our data, however, black depressed patients had a higher cost compared to their depressed white peers. This is consistent with the hypothesis that black BC patients may have more complex problems, possibly related to low health literacy, lack of health insurance, lack of referral to specialists, feelings of neglect, and scarcity of specialty care [42-47]. All of this could contribute to a later stage at diagnosis, more medical complications, more therapeutic procedures, longer hospitalization, and higher costs among black women. It is noted that the higher depression cost (BC^{+D}) was similar across both blacks and whites which is consistent with observations reported for depressed lung cancer, stroke, and heart failure patients [32,48-50]. Inpatient expenditures of cancer survivors were 44% higher in those with depression compared with those without depression. These findings are consistent with the hypothesis that those with depression may have greater length of hospital stay or burden of illness that may contribute to increased expenditures when they are hospitalized. Similar effect of depression on hospital stay was reported by a study in Amsterdam [51] where depression was independently associated with greater lengths of inpatient stay. Briefly, depression increases length of hospitalization when it is associated as a co-morbid condition to any illness.

Limitations

These HDDS administrative files do not provide clinical information regarding tumor size and stage, or severity of other prevailing disease, treatment modalities, or re-imbursement received for the services provided. To preserve confidentiality, patients' assigned ID number changes each year which makes it difficult to undertake follow-up of patients across time. The costs reported here are the charges submitted for payment and not the reimbursed amounts. Further, these administrative files also lack data pertaining to patients' marital status, income, education, or occupation which makes it difficult to assess the effects of social environmental factors. Despite these limitations, our findings contribute significantly to programmatic and policy perspectives.

Conclusion

Since depression increases hospital costs for both blacks and whites, these findings are consistent with the hypothesis that cost savings could be attained by: (i) screening and treating depression among BC patients; and (ii) implementing proven programs that focus on early detection of breast cancer to reduce both morbidity and hospital costs. Analytic epidemiologic studies designed a priori to do so would be required to test these and other hypotheses generated by the present data. Confirmation of these hypotheses could have important effects for patients, healthcare providers and policy makers. Early screening and treatment of depression and greater synchrony between mental health and oncology providers, for example, might lead to better quality of care, lower cost, and improved population health -- all major components of the, "Triple Aim" [52]. Additionally, research is needed to assess the effectiveness of anti-depression co-therapy in breast cancer treatment regimens.

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