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Research Article

Do Co-Morbid Sleep Apnea and Stroke Affect Healthcare Costs? An Analysis of 12,106 Elderly Patients

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Abstract

Background: While obstructive sleep apnea (OSA) is a risk factor for ischemic stroke (IS), it remains unclear whether co-morbid OSA impacts financial burden of care of stroke patients.

Objective: This analysis examines variations in risk factors and hospital cost of elderly patients with OSA and IS.

Design/Methods: We examined 2010 Hospital Discharge Data files (HDDS) for California patients (aged 65+) with a diagnosis of OSA (n = 12,106; male 60%, mean age 76).

Results: Of the 174,315 elderly patients, only 6.9% (n = 12,106) were diagnosed with OSA. Among the OSA group, 13.7% (n = 1,654) had a diagnosis of IS. Among the OSA patients, IS was significantly associated ($p < 0.001$) with hypertension (OR = 1.55), CHD (OR = 1.35), Atrial Fibrillation (AFib) (OR = 1.29), Chronic Kidney Disease (CKD) (OR = 1.17), Obesity (OR = 1.76), Dementia (OR = 9.63), and Depression (OR = 1.38). The cost for OSA alone was 27% higher compared to those without OSA ($164,950 vs. $125,520, a difference of $39,430). The cost for OSA+IS was additionally 22% higher compared to OSA alone ($207,640 vs. $164,950), due in part to a difference in length of hospitalization (20.3 days vs. 15.0 days). The cost difference was even more noticeable among OSA+IS females compared to male peers with similar co-morbidities (F:M; $232,340 vs. $191,610).

Conclusions: Obstructive Sleep Apnea is a treatable condition and a risk factor for stroke. Co-morbid association of these two conditions was associated with higher hospital costs. Additional epidemiologic and clinical studies are needed to determine whether screening and treatment of OSA might reduce the economic burden of OSA and stroke among the elderly.

Keywords: *Elderly; Sleep Apnea; Stroke; Gender; Healthcare Cost*

Abbreviations

HTN-- hypertension;DM- diabtes mellitus; CHOL- high cholesterol; CHD- coronary heart disease; HF- heart failure; MI-myocardial infarction; AFib- atrial fibrillation; COPD- chronic obstructive pulmonary disease; Dement= dementia; Dep- depression; Comorb- number of comp-morbidities; Charlson- Index of comorbid severity; Adm- number of admissions; LOS- length of hospital stay; Total cost $- total cost of the year

Background

Obstructive sleep apnea (OSA) and sleep disturbance or short sleep (< 6 hours of sleep) affects about 15% of American adults [1,2]. OSA prevalence is reportedly higher among males [1,2], African Americans, and adults from lower socio-economic groups [3-6]. OSA is

also associated with cardiovascular disease and depression [7,8], metabolic syndrome/obesity [9,10], hypertension [11,12], diabetes mellitus [13,14], hyperlipidemia [15], coronary heart disease, myocardial infarction, heart failure [16-18], and ischemic stroke (IS) [19], Association with hemorrhagic stroke is less clear [20,21] as is the effect of OSA on hospital cost when stroke is a co-morbid condition. In this analysis, we examined OSA data on elderly discharged patients by gender for three related issues:(1) prevalence of obstructive sleep apnea (OSA) and ischemic stroke (IS) among OSA; (2) risk factors associated with OSA and IS; and (3) effect of OSA and IS on patient hospital costs.

Methods

Sample

We examined 2010 California Hospital Discharge Data (HDDS) on elderly patients (aged 65+; n = 174,315). From this cohort, we selected patients with a diagnosis of sleep apnea (ICD-9 codes 327; n = 12,106, age 76, males 60%) along with their demographics, diagnoses of stroke (ICD 9 codes 430-438), other secondary diagnoses (diagnoses provided by the attending physicians), number of admissions, length of stay (days), and charges (cost) for each discharge during 2010.

Two indices of co-morbidities were computed: (i) a simple count of all secondary diagnoses of the discharged patients that were identified by ICD-9-CM codes; and (ii) Charlson Index [22] of severity of co-morbidities for each patient. Further, a single measure of cost for the year 2010 (Total Cost $) was used which included the cost for OSA discharge plus the cost for the same OSA patient when he/she was discharged with any co-morbid diagnosis.

Statistical analysis: Differences between OSA and Non-OSA patients as well as the prevalence of OSA, risk factors by sex, were all evaluated with logistic regression models, Pearson χ^2 and the Fisher's Exact Tests. Cost differences between groups were evaluated with ANOVA.

Results

Prevalence and risk factors

Overall 6.9% of patients (n = 12,106) had obstructive sleep apnea (OSA) and that OSA was higher among males than females (9.1% vs. 5.2%, p < 0.001). Of these OSA patients, 14% had a co-morbid stroke diagnosis (IS; n = 1,654; only 0.1% were diagnosed with hemorrhagic stroke). IS was higher among male than female patients (15.7% vs. 15.2%, p < 0.05; Table 1, Cols. 3-4). Further, patients with OSA had significant odds (p < .000; Table 1, cols. 5-6) of having hypertension (HTN: OR = 1.31), diabetes mellitus (DM: OR = 1.69), dyslipidemia (OR = 1.11), heart failure (HF: OR = 1.11), atrial fibrillation (AFIB: OR = 1.40), chronic kidney disease (CKD; OR = 1.25), chronic obstructive pulmonary disease COPD (OR = 1.81), obesity (OR = 1.43), and depression (OR = 1.28).

Risk Factors	No OSA	All OSA	OSA Male	OSA Female	OR	95% CI
Col- >	1	2	3	4	5	6
N = →	162,209	12,106	7,245	4,861	-----	-------
Age	80	76	76	76	-------	--------
SAP %	----	6.9	9.1*	5.2	--------	--------
IS %	4.5	3.9	4.2	3.5	----------	------
DEP %	18	25*	20	32*	1.28*	1.22 - 1.33
HTN %	83	89*	88	90*	1.31*	1.23 - 1.39
DM %	40	60*	1.76	61*	1.69*	1.62 - 1.89
CHOL %	9	12	11	12	1.11*	1.04 - 1.18
CHD %	58	61*	67*	53	1.01	0.97 - 1.05
HF %	25	31*	30	32	1.11*	1.00 - 1.16
MI %	12*	9	9	9	0.65	0.61 - 0.70
AFIB %	55	61*	64*	55	1.40*	1.34 - 1.46
CKD %	42	52*	53*	48	1.25*	1.20 - 1.30
COPD %	32	48*	47	50*	1.81*	1.74 - 1.88
Dementia	3.2	1.7	1.6	1.7	0.67	.58 - .78

Table 1: *Risk factor characteristics of OSA by gender.*

**: Differences significant at p < .001 between 2 adjacent column values (1 and 2).*

Similarly, among OSA patients (Table 2, cols. 4-5), IS was significantly ($p < 0.001$) associated with the following: hypertension (OR = 1.55), diabetes mellitus (OR = 1.17), coronary heart disease (OR = 1.35), myocardial infarction (OR = 1.37), atrial fibrillation (OR = 1.29), chronic kidney disease (OR = 1.17), obesity (OR = 1.76), dementia (OR = 9.63), and depression (OR = 1.38). It may be noted that seven (7) risk factors were common to both OSA and IS while dementia emerged as a risk factor for stroke only.

	OSA+ IS	OSA+ IS	OSA+ IS		
Risk Factors	**All**	**Male**	**Female**	**OR**	**9S% CI**
Col- >	1	2	3	4	5
N = →	1,654	1,003	651	-----	-------
Age	77	77	77	-------	--------
IS %	28.7	30.2*	26.4	----------	------
DEP %	30	25	37*	1.38*	1.22 - 1.55
HTN %	-----	92	94+	1.55*	1.25 - 1.99
DM %	63	53	64*	1.17*	1.05 - 1.32
CHOL %	14	13	15	1.11	1.20 - 1.53
CHD %	70	73*	64	1.35*	1.20 - 1.53
HF %	31	30	32	0.86	0.76 - 0.97
MI %	13	13	14	1.37*	1.15 - 1.62
AFIB %	67	69*	63	1.29*	1.15 - 1.44
CKD %	58	59+	57	1.17*	1.04 - 1.31
COPD %	45	43	47*	0.79	0.71 - 0.89
Dement%	7.5	7.4	7.7*	9.63*	7.2 - 12.9

Table 2: *Characteristics of OSA Patients with stroke by Gender, 2010.*
*+ and * refers to gender differences significant at $p < .01$ and $p < .001$ respectively.*

Effect of OSA and stroke on hospital costs

Table 3 shows that the average cost per year for OSA ($164,950) was 27% higher compared to patients without OSA ($164,950 vs. $125,520, cols. 1-2). OSA costs were higher ($p < 0.001$) for women than men ($177,880 vs. $156,280, cols. 3-4). When ischemic stroke (IS) was added to the analysis, the OSA cost increased by an additional 22%, from $164,950 to $207,640 (cols. 2 and 5). Moreover, these costs nearly doubled for patients with both sleep apnea and stroke (OSA+IS) compared to patients without such characteristics ($207,640 vs. $125,520, cols. 1 and 5). Further, these OSA+IS costs were also higher among females than males ($232,340 vs. $191,610, cols. 6 and 7), partly due to longer hospitalization (23.7 days vs. 18.1 days). In sum, OSA+IS increased the hospital costs significantly, particularly for elderly females who suffered from both OSA+IS compared to males without such characteristics.

Factors	**NO-OSA**	**OSA ALL**	**OSA Male**	**OSA Female**	**OSA+IS ALL**	**OSA+IS Male**	**OSA+IS Female**
Col	1	2	3	4	5	6	7
n	162,209	12,106	7,245	4,861	1,654	1,003	651
Age	81	76	76	76	77	77	77
Comorb	3.8	4.5	4.5	4.5	4.9	4.9	5.0
Charson	3.6	4.3	4.3	4.3	5.1	5.1	5.1
Adm.	1.6	2.1	2.0	2.2*	2.6	2.5	2.8*
LOS	12.3	15.0	13.5	17.3*	20.3	18.1	23.7*
Total Cost $	125,520	164,950*	156,280	177,880*	207,640	191,610	232,340*

Table 3: *Hospital cost of OSA patients with ischemic stroke by gender, 2010.*
**: Differences between adjacent columns are significant at $p < .001$.*

Discussion

This very large elderly cohort of patients (n = 12,106) representing all major ethnic groups in California, had a lower prevalence of diagnosed OSA (6.9%) than OSA prevalence reported by other studies that included patients with varying ages [19,23]. Our study was designed to examine variations in risk factors and healthcare costs of elderly patients by gender. While significant OSA risk factors existed in this sample, diagnosed IS affected only 13.7% of the OSA population. This observed prevalence of IS among OSA is lower than that reported by others. For example, Yaggi and colleagues [19] reported a diagnosis of OSA among 68% their patients (n = 1,022). OSA in their study was significantly associated with both stroke and mortality [19,23,24].

Our results are consistent with the hypothesis that patients with co-morbid stroke and OSA will have a significant increase in hospitalization cost [25] compared to cost for either condition alone or without either condition. In all patients we found a 27% higher cost of care among patients with associated OSA($164,950 vs. $125,520). Further, co-morbid association of OSA with IS increased the cost of care by another 22% ($207,640 vs. $164,950). The cost for females compared to males with OSA was higher ($177,880 vs. $156,280, a difference of $21,600 per patient), largely due to longer hospitalization of females. This higher female cost remained intact when we examined gender differences in cost for OSA+IS. Here, the female –to- male cost were $$232,340 and $191,610 respectively, a difference of $40,730. The higher female costs, associated with longer hospital stays (female 24 days vs. male 18 days) relates, at least in part, to a higher prevalence of depression among females (F32% vs. M20%, $p < 0.001$). Depression is known to increase both length of hospitalization (days) and hospitalization costs in other conditions such as lung cancer, heart failure, and stroke [26-29]. Our findings on this large sample of elderly patients, though somewhat similar to previous smaller studies [23,24,30,31], point to continued implementation of preventive programs that help control well-established risk factors to lower morbidity and healthcare costs.

Implications for OSA screening and treatment are unclear. The United States Preventive Services Task Force (USPSTF) recently completed an extensive review of evidence pertaining to OSA screening for asymptomatic adults. In all, 110 studies involving 46,188 participants were included. The authors concluded that, "There is uncertainty about the accuracy or clinical utility of all potential screening tools. Multiple treatments for OSA reduce AHI [(apnea-hypoxia index)], ESS [(Epworth Sleepiness Scale)] scores, and blood pressure. Trials of CPAP [(Continuous Positive Airway Pressure)] and other treatments have not established whether treatment reduces mortality or improves most other health outcomes, except for modest improvement in sleep-related quality of life" [32]. Overall, the USPSTF concluded that current evidence is insufficient to recommend for or against OSA screening [33].

Limitations

The Hospital Discharge files (HDDS) are administrative files which do not provide clinical information regarding stage of disease, test results, or treatment modalities. In order to preserve confidentiality, patients ID changes each year which also prevents follow-ups to determine changes overtime. Further limitations include lack of patients' marital status, income, education, or occupation to obtain social determinants. The costs reported are charges submitted for payment; they are not reimbursed amounts. Despite these limitations, our findings are consistent with the need for future studies to improve understanding about clinical and economic factors affecting these conditions.

Conclusion

Ischemic stroke is associated with increased hospital costs for OSA patients regardless of gender. The higher OSA+IS costs among females reflects, at least in part, the additional burden of depression, along with hypertension, and diabetes. Our findings support the need for additional epidemiologic and clinical studies to determine whether screening and treating OSA and IS risk factors can improve health and reduce healthcare cost.

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