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SCIENTIFIC INVESTIGATIONS

Sleep Apnea in an Urban Public Hospital: Assessment of Severity and Treatment Adherence

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Objective: To assess obstructive sleep apnea (OSA) severity, continuous positive airway pressure (CPAP) adherence, and factors associated with CPAP adherence among a group of patients with OSA receiving care at a publicly funded county hospital.

Study Design and Setting: A retrospective cohort study in a 464-bed urban public hospital in Cook County, Illinois.

Results: A total of 507 patients were included. They had a mean (SD) age of 46.9(11) years, mean body mass index of 46.2 (11.0) kg/m2; mean and median baseline apnea-hypopnea index (AHI) of 71.0 (44.4) and 69.5 episodes/h; mean Epworth Sleepiness Scale (ESS) score of 15.8 (6.1). Of these patients, 53% were men, 74% did not have health insurance coverage, and 77% were African American. Mean CPAP adherence of the 323 patients with follow-up data was 3.87 (2.62) hours/day, with 47.7% of subjects using CPAP objectively for ≥4 hours/day. Women were 2.49 (95% CI, 1.39-4.46) times more likely to be nonadherent than men, after adjusting for race, marital status, and age. Of the 172 patients who did not follow up, there were disproportionately more men. When individuals without follow-up were assumed to be nonadherent, the overall compliance rate was 30.4%, and women were 1.72 (95% CI, 1.03-2.88) times more likely to be noncompliant than men, adjusting for race, marital status, and age.

Conclusion: This study population experienced severe OSA. CPAP adherence was low, with women having a higher likelihood of nonadherence than men. With the epidemic of obesity and increased awareness of OSA, this population should be further studied to diminish future health disparities in the treatment of this disease.

Keywords: Sleep-disordered breathing, severity of disease, urban population, treatment adherence

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Obstructive sleep apnea (OSA) is a condition characterized by repetitive episodes of breathing cessation during sleep due to upper airway obstruction. The primary risk factor for OSA is obesity with other prominent risk factors being increasing age and male gender.

OSA is a common disease in the United States affecting over 12 million people. A Wisconsin cohort study estimated the prevalence of OSA to be 2% in women and 4% in men ages 30 to 60.[1] Symptoms of OSA include excessive daytime sleepiness, cognitive dysfunction, and diminished quality of life. Complications associated with OSA include systemic arterial hypertension,[2-4] cardiac problems,[5-8] cerebrovascular accidents,[5,9] insulin resistance and diabetes mellitus,[10-12] accidental death due to cognitive impairment,[13-15] and death.[16]

Minority populations, in particular African Americans, demonstrate a much higher prevalence of obesity compared to whites.[17-19] African Americans also have a higher prevalence than whites of cardiovascular risk factors, including hypertension and diabetes mellitus.[20-22] Based on these trends and previous studies, the prevalence of sleep disordered breathing in this population may also be higher.[23,24] Greenberg et al. compared patients from a voluntary hospital and city hospital-based minority serving institution (MSI) and found that the MSI patients had a greater body mass index, more comorbid medical conditions, and lower minimum sleep oxygen saturation. Forty-two percent of the MSI patients diagnosed with OSA failed to follow up for treatment, compared with 7% in the voluntary hospital group.[25]

Continuous positive airway pressure (CPAP) is an effective first line therapy for OSA, along with lifestyle modifications, leading to reduction of symptoms and improvement in cognitive function and quality of life.[26] However CPAP therapy may not be well tolerated, and few studies have specifically focused on the pattern and treatment adherence of OSA in low-income minority urban populations. The urban patient population studied by Kribbs et al. had an adherence rate of 46%, when regular use was defined by at least 4 hours of CPAP a day; the sample size, however, was relatively small.[27]

The purpose of this study was to assess OSA severity, CPAP adherence, and factors associated with CPAP adherence among a group of patients with OSA receiving care at a publicly funded county hospital.

Disclosure Statement

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MATERIALS AND METHODS

This study was approved by the Institutional Review Board at the University of Illinois At Chicago.

Subject Identification

Subjects were cared for at Cook County Hospital (currently John H. Stroeger Jr. Hospital of Cook County) by the physicians and staff from the Rush-Presbyterian-St. Luke's Sleep Disorders Center. The clinic was part of a joint venture between the hospitals.

Patients seen at the Cook County Sleep Clinic underwent an initial evaluation and subsequent polysomnography (PSG), if recommended by the physician. The diagnosis of OSA required an apnea/hypopnea index >5 per hour on the PSG. An obstructive apnea was defined as cessation of nasal-oral airflow lasting at least 10 seconds with evidence of continuous respiratory effort. An obstructive hypopnea was defined as a reduction in nasal-oral airflow lasting at least 10 seconds, accompanied by either a 4% reduction in oxygen saturation without an arousal or a reduction in oxygen saturation of less than 4% followed by an arousal. An arousal was defined as 3 consecutive seconds of alpha waves on the central leads of the electroencephalography. The AHI was calculated as the number of apneas and hypopneas per hour of total sleep time and was scored according to the recommendations of the American Academy of Sleep Medicine.[28] Patients with OSA received a CPAP machine and training and were given an appointment for a follow-up visit one month later. Subjects were enrolled from July 1999 and followed to April 2004. Patients included in this analysis were those who met the diagnostic criterion of OSA, received a CPAP machine and training, and were given a follow-up appointment date.

Polysomnography and CPAP machine

A standard 12-channel polysomnogram at the Rush-Presbyterian-St. Luke's Sleep Disorders Center was used for all patients. The electromyogram, electrooculogram, and electroencephalogram leads were applied according to the international 1020 electrode placement system. CPAP machines and training were provided by 2 durable medical equipment companies who agreed to participate under a fee-for-service program where the patients were educated and provided equipment in the outpatient sleep clinic. CPAP compliance machines with a microchip from either Respironics® or Resmed® were provided to all patients. CPAP compliance data was downloaded from the microchips and converted to an Excel® format by the physician and nurse practitioner.

Statistical Analysis

The means and standard deviations of normally distributed continuous variables were compared using the two-tailed Student's t test. Ordinal and categorical variables were compared using a Chi-square test or Fisher's exact test. The apnea hypopnea index (AHI) did not fulfill the assumption of normality; therefore, a square root transformation of AHI was used. All p-values <0.05 were considered significant. All analyses were performed using SAS (SAS release 8.02). A multiple logistic regression model was used to determine odds ratios.

Table 1—Demographics and Baseline Characteristics of Cohort.*

Patient Number	507
Male patients, %	52.7%
Race	
African American	77%
Hispanic	15%
Caucasian	6%
Asian/Pacific Islander	2%
Comorbidities,%	
Diabetes	25%
Hypertension	61%
Married, %	25%
Age, y	46.9 (11.9)
Body Mass Index, kg/m2	46.2 (11.0)
	71.0 (44.4)
Apnea-Hypopnea Index (AHI),	Median 69.5
Number of events per hour	Minimum 5.3
	Maximum 199.0
No insurance coverage, %	74%
Epworth Sleepiness Scale score	15.8 (6.1)

*Data presented as mean (SD) unless otherwise stated.

Outcome Measures

CPAP use of less than 4 hours/day averaged over 30 days was considered noncompliant. The following factors were evaluated as predictors for CPAP noncompliance: age, race, sex, marital status, baseline apnea-hypopnea index (AHI), Epworth Sleepiness Scale (ESS), and insurance status.

Sensitivity Analysis

In order to better understand the robustness of our findings, a sensitivity analysis was done to understand the impact of the individuals who did not follow up. Significant findings during the analysis of the individuals who followed up and provided adherence data were repeated with the inclusion of the individuals who did not follow up. In this sensitivity analysis, we assumed the individuals who did not follow up were nonadherent to CPAP therapy.

RESULTS

Between July 1999 and April 2004, 507 patients diagnosed with OSA documented by PSG received CPAP machines. As shown in Table 1, hypertension and diabetes mellitus were self-reported in 61% and 25% of this study group, respectively. The mean (SD) age of the 507 subjects was 46.9(11) years; 52.7% were male. Seventy-seven percent of subjects self-reported themselves as African American, and 74% did not have health insurance coverage. The mean degree of OSA was severe, with a mean apnea-hypopnea index (AHI) of 71.0 (44.4) episodes per hour and a median of 69.5 episodes per hour. The average body mass index (BMI) was 46.2 (11.0) kg/m^2 with 100% of patients being obese based on Centers for Disease Control (CDC) guidelines (BMI $\geq$30 kg/m^2).

Of the 507 patients, 335 presented for the follow-up appointment and provided CPAP adherence data. Of the 335 patients, 323 had adequate CPAP adherence data for analysis. Mean CPAP

Table 2—CPAP Nonadherence and Sex.

Variable	Covariate	OR	95% CI
Female		1.57	(1.01-2.44)
Female	Race	1.94	(1.17-3.23)
Female	Marital status	1.76	(1.10-2.84)
Female	Age	1.77	(1.11-2.81)
Female	Race, Marital status	2.19	(1.27-3.77)
Female	Race, Age	2.28	(1.33-3.91)
Female	Marital Status, Age	2.00	(1.20-3.32)
Female	Race, Marital status, Age	2.49	(1.39-4.46)

use was 3.87 (2.62) hours/day with 47.7% of subjects using CPAP objectively for ≥4 hours/day averaged over 30 days. Sex and race were the only independent variables found to be significantly associated with CPAP nonadherence. The results in Table 2 show that women were 1.57 (95% CI, 1.01-2.44) times more likely to be nonadherent than men. Women were 2.49 (95% CI, 1.39-4.46) times more likely to be nonadherent than men after adjusting for race, marital status, and age (Table 2).

When individuals without follow-up were assumed to be nonadherent, the overall adherence rate was 30.4% and women were 1.72 (95% CI, 1.03-2.88) times more likely to be nonadherent than men, adjusting for race, marital status, and age.

African Americans were 5.02 (95% CI, 1.59-15.84) times more likely to be nonadherent than Caucasians (Table 3). However, this finding may be biased because of the small number of Caucasians compared with African Americans (196 African Americans versus 18 Caucasians). There were also small numbers of subjects who were categorized as Hispanic and Asian/Pacific Islander. The odds of nonadherence were not significant when comparing any other ethnic groups.

DISCUSSION

This study describes the patient demographics and poor adherence to the treatment of sleep disordered breathing in a population cared for at an urban public hospital. Treatment adherence was low in patients who followed up and were included in the analysis; however, this is likely an overestimation of the overall adherence of CPAP considering the lack of follow-up in patients diagnosed with this disease. When individuals without follow-up were assumed to be nonadherent, the overall adherence rate was only 30.4%.

OSA is a common disease in the United States, and the overall prevalence based on diagnostic criteria is thought to be greatly underestimated. Minorities have a higher prevalence of obesity and medical comorbidities and therefore likely a higher OSA prevalence. There are serious and life-threatening complications associated with OSA and adherence to treatment is imperative. In this predominantly minority and largely uninsured cohort of patients receiving care at a publicly funded county hospital, women and African Americans were more likely to be nonadherent than men and Caucasians, respectively. Since the majority of this population is African American, the relationship between these two races, although significant, is questionable as evidenced by the wide confidence interval. A study involving a larger Caucasian population for comparison will be needed to elucidate whether this difference truly exists.

Table 3—CPAP Nonadherence and Race.

Variable	Covariate	OR	95% CI
African American		5.02	(1.59-15.84)
African American	Sex	4.26	(1.33-13.62)
African American	BMI	6.37	(1.77-22.94)
African American	Sex, BMI	5.51	(1.51-20.09)

Table 4—Demographics and Baseline Characteristics of Patients With and Without Follow-up.

	CPAP follow-up	No CPAP follow-up	P-value
Patient Number	323	172	
Male, %	48.6%	61%	0.009
African American, %	74.5%	81.3%	0.478
Married, %	28.5%	16.7%	0.008
Age, y	48.7 (11.1)	43.5 (12.8)	0.261
Body Mass Index, kg/m2	45.9 (11.2)	46.7 (10.8)	0.997
AHI, events/h	70.0 (43.7)	72.5 (45.8)	0.959
No insurance coverage, %	72.7%	79.3%	0.134
Epworth Sleepiness Scale score	16.1 (5.9)	15.1 (6.5)	0.369

Data presented as mean±SD unless otherwise stated.

The 172 subjects who did not follow up is a limitation in this study. Among the non–follow-up group, smaller proportions were women and married individuals compared with the follow-up group, creating potential selection bias (Table 4). However, when the analysis was repeated assuming the non–follow-up group to be nonadherent, women were still more likely to be nonadherent compared to men, after adjusting for race, marital status, and age. The reason for the low adherence in this cohort is not clear. We had limited data on income and true socioeconomic status based on income and total number of family members. Lack of social support systems may have been a contributing factor. Women in this cohort may be of lower socioeconomic status and have less social support then men, however, these variables were not available for our study.

This cohort of patients is at significant risk of having undiagnosed OSA and experiencing related complications due to poor access and limited utilization of health care. We describe a unique program that provides care for uninsured, minority individuals in a manner similar to patients with the best of health insurance. Despite the elimination of diagnosis and treatment obstacles for sleep apnea, treatment adherence was found to be lower than other populations.

A study by Kripke et al. found frequency of disease was much higher among members of minority groups, ages 40-64, based on measurements of oxygen desaturations.[24] Given the high prevalence of obesity and OSA-associated comorbidities in minority populations, the ability to diagnose and effectively treat sleep apnea has the potential to significantly improve the health of minority populations. Further study should focus on additional characteristics that may affect adherence such as socioeconomic status, educational level, and social support systems. By identifying these factors, interventions could be developed and implemented to improve adherence to therapy and diminish

the disease burden in similar populations. With the epidemic of obesity and increased awareness of OSA, this population should be further studied to decrease future health disparities in the treatment of this disease

REFERENCES

1 Young T, Palta M, Dempsey J, Skatrud J, Weber S, Badr S. The occurrence of sleep-disordered breathing among middle-aged adults. N Engl J Med 1993;328:1230-5.

2 Nieto FJ, Young TB, Lind BK, et al. Association of sleep-disordered breathing, sleep apnea, and hypertension in a large community-based study. Sleep Heart Health Study. JAMA 2000;283:1829-36.

3 Peppard PE, Young T, Palta M, Skatrud J. Prospective study of the association between sleep-disordered breathing and hypertension. N Engl J Med 2000;342:1378-84.

4 Bixler EO, Vgontzas AN, Lin HM, et al. Association of hypertension and sleep-disordered breathing. Arch Intern Med 2000;160:2289-95.

5 Shahar E, Whitney CW, Redline S, et al. Sleep-disordered breathing and cardiovascular disease: cross-sectional results of the Sleep Heart Health Study. Am J Respir Crit Care Med 2001;163:19-25.

6 Harbison J, O'Reilly P, McNicholas WT. Cardiac rhythm disturbances in the obstructive sleep apnea syndrome: effects of nasal continuous positive airway pressure therapy. Chest 2000;118:591-5.

7 Peker Y, Kraiczi H, Hedner J,Loth S, Johansson A, Bende Ml. An independent association between obstructive sleep apnoea and coronary artery disease. Eur Respir J 1999;14:179-84.

8 Mooe T, Rabben T, Wiklund U, Franklin KA, Eriksson P. Sleep-disordered breathing in men with coronary artery disease. Chest 1996;109:659-63.

9 Dyken ME, Somers VK, Yamada T, Ren ZY, Zimmerman MB. Investigating the relationship between stroke and obstructive sleep apnea. Stroke 1996;27:401-7.

10 Ip MS, Lam B, Ng MM, Lam WK, Tsang KW, Lam KS. Obstructive sleep apnea is independently associated with insulin resistance. Am J Respir Crit Care Med 2002;165:670-6.

11 Punjabi NM, Sorkin JD, Katzel LI, Goldberg AP, Schwartz AR, Smith PL. Sleep-disordered breathing and insulin resistance in middle-aged and overweight men. Am J Respir Crit Care Med 2002;165:677-82.

12 Vgontzas AN, Papanicolaou DA, Bixler EO, et al. Sleep apnea and daytime sleepiness and fatigue: relation to visceral obesity, insulin resistance, and hypercytokinemia. J Clin Endocrinol Metab 2000; 85:1151-8.

13 Lindberg E, Carter N, Gislason T, Janson C. Role of snoring and daytime sleepiness in occupational accidents. Am J Respir Crit Care Med 2001;164:2031-5.

14 Masa JF, Rubio M, Findley LJ. Habitually sleepy drivers have a high frequency of automobile crashes associated with respiratory disorders during sleep. Am J Respir Crit Care Med 2000; 162:1407-12.

15 Teran-Santos J, Jimenez-Gomez A, Cordero-Guevara J. The association between sleep apnea and the risk of traffic accidents. Cooperative Group Burgos-Santander. N Engl J Med 1999;340:847-851.

16 He J, Kryger MH, Zorick FJ, Conway W, Roth T. Mortality and apnea index in obstructive sleep apnea. Experience in 385 male patients. Chest 1988;94:9-14.

17 Zhang Q, Wang Y. Socioeconomic inequality of obesity in the United States: do gender, age, and ethnicity matter? Soc Sci Med 2004;58:1171-80.

18 Denney JT, Krueger PM, Rogers RG, Boardman JD. Race/ethnic and sex differentials in body mass among US adults. Ethn Dis 2004; 14:389-98.

19 From the Centers for Disease Control and Prevention. Update: prevalence of overweight among children, adolescents, and adults—United States, 1988-1994. JAMA 1997; 277:1111

20 Racial/ethnic disparities in prevalence, treatment, and control of hypertension—United States, 1999-2002. MMWR Morb Mortal Wkly Rep 2005; 54:7-9

21 Harris MI, Flegal KM, Cowie CC, et al. Prevalence of diabetes, impaired fasting glucose, and impaired glucose tolerance in U.S. adults. The Third National Health and Nutrition Examination Survey, 1988-1994. Diabetes Care 1998; 21:518-524

22 Carter JS, Pugh JA, Monterrosa A. Non-insulin-dependent diabetes mellitus in minorities in the United States. Ann Intern Med 1996;125:221-32.

23 Redline S, Tishler PV, Hans MG, Tosteson TD, Strohl KP, Spry K. Racial differences in sleep-disordered breathing in African-Americans and Caucasians. Am J Respir Crit Care Med 1997;155:186-92.

24 Kripke DF, Ancoli-Israel S, Klauber MR, Wingard DL, Mason WJ, Mullaney DJ. Prevalence of sleep-disordered breathing in ages 40-64 years: a population-based survey. Sleep 1997;20:65-76.

25 Greenberg H, Fleischman J, Gouda HE, et al. Disparities in obstructive sleep apnea and its management between a minority-serving institution and a voluntary hospital. Sleep Breath 2004; 8:185-92.

26 Ballester E, Badia JR, Hernandez L, et al. Evidence of the effectiveness of continuous positive airway pressure in the treatment of sleep apnea/hypopnea syndrome. Am J Respir Crit Care Med 1999;159:495-501.

27 Kribbs NB, Pack AI, Kline LR, et al. Objective measurement of patterns of nasal CPAP use by patients with obstructive sleep apnea. Am Rev Respir Dis 1993; 147:887-95.

28 Sleep-related breathing disorders in adults: recommendations for syndrome definition and measurement techniques in clinical research. The Report of an American Academy of Sleep Medicine Task Force. Sleep 1999; 22:667-689