



Domiciliary continuous positive airway pressure therapy in an underserved population: compliance and influential factors

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Abstract

Obstructive sleep apnea syndrome is an increasingly recognized global epidemic [1]. Uninsured patients frequently lack access to specialized testing, treatment and specialists access. Such patients may have conflicting priorities that affect their ability to comply with sleep apnea therapy. Carolinas Sleep Services has an Ambulatory Sleep program in which uninsured patients in Mecklenberg County, NC are provided both diagnostic and treatment options at either no or minimal charge. We retrospectively reviewed the chart data for 236 patients at the Carolina Sleep Services Ambulatory Clinic to assess patient adherence to PAP therapy in this low-income population. 149 (63%) of the 236 patients were recommended to have positive airway pressure therapy; the remaining 87 patients were not recommended PAP therapies. Compliance reports were obtained for only 30 of the 149 patients; patients were not given CPAP devices with modems and the return of card data was a challenge. Of those with compliance reports, 14 (47%) were compliant with their therapy. However, since this study had severe limitations, further research into methods for improving therapeutic compliance in uninsured or low-income populations is suggested. Approaches for addressing PAP compliance in underserved populations may also be linked to broader issues of access to healthcare in this population.

Keywords: Compliance, positive airway pressure therapy, underserved population, obstructive sleep apnea syndrome, sleep disorder

Introduction

Obstructive sleep apnea syndrome (OSAS) is an increasingly recognized global epidemic [1]. The current standard of treatment for moderate to severe OSAS is positive airway pressure (PAP) therapy [2]. However, diagnosis and treatment methods are expensive, and often unaffordable to those that are economically challenged and/or uninsured [3,4,9]. Reports in the literature suggest that patients from lower SES backgrounds encounter barriers to diagnosis of OSAS and have lower therapy adherence rates [3,4,7,9].

Carolinas HealthCare System offers a sliding scale payment program for uninsured patients that live in Mecklenberg County. Carolina Sleep Services (CSS), in partnership with its sleep physicians and associated clinics in Mecklenberg County, attempts to serve those uninsured or low-income patients who are diagnosed with OSAS in a manner that improves access to care and reduces patient cost without sacrificing quality. As part

of this, CSS instituted a telemedicine-based ambulatory clinic; eligible patients are Mecklenberg County residents who have established a primary care provider through the sliding-scale primary care clinic. Similarly, together with Carolinas Healthy at Home, CSS provides PAP treatment options to sleep apnea patients who are on a sliding scale and are uninsured.

Previous research has documented many reasons for non-adherence ranging from: affordability, the need for more OSAS pathophysiology and PAP therapy education, support from family/friends and medical providers, personal beliefs, disease perception, along with other factors. The inter-relationships of these factors pose a significant research challenge in OSA as well as other chronic disorders [3-7,9].

Untreated or undertreated OSAS can exacerbate comorbidities such as diabetes, atrial fibrillation, congestive heart failure, myocardial infarctions, stroke, and therefore the effects of proper treatment and adherence may have broader impli-

cations [3,8]. The goal for this study was to assess compliance with PAP therapy and any associated factors that affected compliance in a low-income/uninsured population at home.

Methods

The ongoing CSS program followed the following protocol: Patients with a prior diagnosis of sleep apnea were sent directly to Healthy at Home for initiation of PAP therapy. Board-certified sleep physicians for further review and determination of appropriate testing screened patients without a prior diagnosis through the electronic health record. Patients with suspected sleep apnea were then referred to CSS-Mercy for a daytime sleep study with a limited channel hook up. Patients diagnosed with significant obstructive sleep apnea were then placed on an auto-titration PAP device to determine proper home settings. A refurbished or low cost PAP machine was then provided to the patients.

Selection criteria for the intended population included if the patient was underinsured or uninsured and had already met the qualifications to be on the sliding scale, based off of low household income, through Carolinas Healthcare System. The time frame used for the retrospective chart review was from January 1, 2011 to January 1, 2013. Demographic information used from the databases included age, gender, race, BMI. The diagnostic data from the daytime sleep study included the apnea hypopnea index and oxygen desaturation levels were also analyzed statically. Other variables in this population included diabetes, strokes, Atrial Fibrillation, Congestive Heart Failure and Myocardial Infraction.

We conducted a retrospective review of 236 patients seen in the Ambulatory Clinic between January 2011 and January 2013. Data was collected from Carolinas Healthcare System Electronic Health Record and from the Carolinas Sleep Services database. Information obtained from the databases included age, gender, race, BMI, diagnosis of diabetes and associated HgbA1c values, prior stroke occurrence, and diagnosis of atrial fibrillation, congestive heart failure and myocardial infraction. Diagnostic data analyzed from the daytime sleep study included the apnea hypopnea index and oxygen desaturation levels. The apnea hypopnea index was categorized using the American Academy of Sleep Medicine groups of mild (5-15 events/hour), moderate (15-30 events/hour), and severe (>30 events/hour) [9]. We defined compliance as the use of the PAP machine by the patient for at least 4 hours per night. Data collation and analysis were performed using Microsoft Excel 2011. The statistical tests used to determine significance were Chi-square and t-tests. The study was approved by the Institutional Review Board (IRB # 02-13-29E).

Results

Table 1 shows the demographic and clinical characteristics of patients referred for PAP therapy and those either not referred for therapy or who refused therapy and returned their machine. Patients who were not referred or who refused PAP tended

Table 1. Participant demographic and medical characteristics, by PAP therapy referral status (total N=236).

Characteristic	Patients referred for PAP therapy (N=149)	Patients not referred for PAP therapy (or refused therapy) (N=87)
Race (n (%))		
Black	114 (77%)	67 (77%)
White	26 (17%)	10 (11.5%)
Other of unknown	9 (6%)	10 (11.5%)
Female (n (%))	49 (33%)	84 (97%)
Age (mean)	48.2	46.9
BMI (mean)	40.1	35.4
AHI (mean)	29.7	2.5
PSG oxygen saturation (mean)	83%	89%
Diabetic (n (%))		
Prior stroke (n)	63 (42%)	12 (14%)
Prior MI (n)	1	0
Prior atrial fibrillation (n)	1	0
Congestive heart failure (n)	7	0
Sleep apnea level		
Mild	68 (46%)	0
Moderate	39 (26%)	0
Severe	42 (28%)	0
Type of PAP therapy (n (%))		
Bi-level (n)	2	0
Continuous (n)	147	0

to have lower AHI (mean AHI=2.5) than those who were referred for PAP therapy (mean AHI=29.7), had higher PSG oxygen saturations (mean=89% vs. mean=83% for patients referred for therapy), younger in age (mean=46.9 years vs. 48.2 years for patients referred for PAP therapy) and lower BMI (mean=35.4 vs. 40.1 for patients referred for PAP therapy). With respect to existing medical conditions, significantly more people with diabetes were referred for PAP therapy, than those who were not referred or who refused therapy ($\chi^2(1)=34.68$; $p<0.0001$). Of those participants referred for PAP therapy, none had a prior stroke, one had a prior MI, one had prior atrial fibrillation, and 7 had congestive heart failure. Of those participants who were not referred or who refused PAP therapy, none had prior stroke, MI, atrial fibrillation, or congestive heart failure.

Relatively few compliance reports were found for the patients who were referred to PAP therapy (and who did not refuse therapy—see **Table 2**). Although the presence or absence of compliance reports was not entirely due to patient characteristics, those without reports tended to have slightly higher AHI (30.1 mean AHI compared to 27.9 AHI in patients with compliance reports), younger in age (40.4 mean age compared to 49 mean age of those with compliance reports), and slightly higher PSG oxygen saturation. Also, significantly

Table 2. Participant demographic and medical characteristics, by presence of compliance report (for those on PAP therapy; N=149).

Characteristic	Patients with compliance reports (N=30)	Patients without compliance reports (N=119)
Race (n (%))		
Black	25 (83%)	89 (75%)
White	4 (13%)	19 (16%)
Other or unknown	1 (3%)	11 (9%)
Female (n (%))	13 (43%)	58 (49%)
Age (mean)	49	40.4
BMI (mean)	39.2	40.4
AHI (mean)	27.9	30.1
PSG oxygen saturation (%)	82%	83%
Diabetic (n (%))	10 (33%)	53 (45%)
Prior stroke (n (%))	0 (0%)	0 (0%)
Prior MI (n (%))	1 (3%)	0 (0%)
Prior atrial fibrillation (n (%))	0 (0%)	1 (0.8%)
Congestive heart failure	3 (0.1%)	4 (3%)
Type of PAP therapy (n)		
Bi-level	1	--
Continuous	29	--
Showed at follow-up appointments	30	0
Doctors' notes in charts recorded that compliance information was obtained	30	0

more of the patients without compliance reports had a prior diagnosis of type two diabetes ($X^2(1)=29.349$; $p<0.0001$).

Table 3 shows that only 14 patients (47%) of the 30 with compliance reports complied with their PAP therapy. The range of hours of use was 4.35 hours to 9.54 hours, compared with the range of 0.51 hours to 3.5 hours for patients who were noncompliant.

Patients who were non-compliant tended to have higher AHI (29.7), higher BMI (40.3), younger (48) and have a prior diagnosis of type two diabetes; although the differences in AHI, BMI, and age were not statistically different. There was no significant difference in compliance with regard to sex ($x^2(1)=0.077$; $p=0.7815$) or race (black, $x^2(1)=0.040$; $p=0.8415$) (white, $x^2(1)=1.000$; $p=0.3173$) (other, $x^2(1)=1.000$; $p=0.3173$), when comparing compliant vs. non-compliant patients, both who had compliance reports (N=30). There was a high statistically significant difference in the hours per night patients who were compliant (with compliance reports) used PAP (mean=5.94 hours) compared to non-compliant patients, with compliance reports (mean=1.97 hours) ($p<0.0001$).

Discussion and Conclusion

This study is consistent with previous research in that less than half (47%) of participants with compliance reports are

Table 3. Participant demographic and medical characteristics, by adherence status, for those PAP therapy patients with a compliance report*.

Characteristic	Compliant patients (N=14)	Noncompliant patients (N=16)	p-value for comparison (*)
Race (n (%))			
Black	13 (93%)	12 (75%)	0.8415
White	1 (7%)	3 (19%)	0.3173
Other or unknown	0 (0%)	1 (6%)	0.3173
total	14	16	0.7150
Female (n (%))	6 (43%)	7 (44%)	0.7815
Age (mean (SD))	50 (6.79)	48 (7.75)	0.4957
BMI (mean (SD))	37.9 (8.57)	40.3	0.5492 (12.07)
AHI (mean (SD))	25.9 (30.21)	29.7 (25.29)	0.7079
PSG oxygen saturation (mean)	82%	82%	--
Diabetic (n (%))	2 (14%)	8 (50%)	0.0578
Prior stroke (n (%))	0 (0%)	0 (0%)	--
Prior MI (n (%))	1 (0%)	0 (0%)	--
Prior atrial fibrillation (n (%))	0 (0%)	0 (0%)	--
Congestive heart failure (n (%))	1 (7%)	2 (12%)	--
Type of PAP therapy (n)			
Bi-level	0	1	--
Continuous	14	15	--
Hours per night used PAP machine (mean (SD))	5.94 (1.75)	1.97 (1.75)	<0.0001

*p-values for Age, BMI, AHI, PSG Oxygen saturation, and Hours per night used PAP machine are t-tests (95% CI); all others are Chi-square tests.

compliant with PAP therapy.

One of the major limitations of the study was the number of compliance reports available from the electronic databases. Although there were some problems that were due to patient lack of adherence –e.g., 55% of patients failed to show for follow up appointments –**Table 2** shows that there were also provider-related issues, including delays in setting up the PAP machines, provision of PAP machines without modem capacity, and improper use of the PAP machines with modem capacity. (With respect to the latter case, some providers did not use the recordings of nightly usage provided by the PAP machines but instead during follow-up visits but instead used a manometer to measure the machine's pressure level and asked patients for a verbal report of whether the machine was used on a nightly basis). Some of these are likely cost-related in source, but others are either ambiguous or suggest a practice-related concern. This suggests either that more PAP devices were being used with the capability to transmit nightly usage data or providers were becoming more aware of the need to track compliance.

Other operational or logistical issues that hindered the

collection of compliance data included the following: no consistent notations of the actual type (brand of machine) of PAP device being issued, no tracking of the type of mask being issued, and no mention of whether humidifiers were being used with the PAP device.

Some of the problems and barriers reported by patients (Table 3) should be addressed on a population level. While issues such as how well the mask fits cannot be addressed globally, others, such as the affordability of the PAP machine, may be amenable to programmatic solution. Low-income or uninsured individuals often must prioritize their spending in favor of housing or food over medical expenses. The future potential costs due to OSAS-associated comorbidities may be preventable in this population if PAP therapy is made more affordable in terms of savings in time, effort, and monetary cost.

Enhancing compliance with PAP therapy will increase the treatment rate of OSAS, in turn improving an underserved community's health. In the future, programs addressing issues of affordability, tracking compliance, providing education on the hazards of sleep apnea, and training patients to use PAP devices and masks in this population will be key in cultivating PAP adherence. Moving forward, future research will face multifaceted obstacles in the pursuit to improve compliance to PAP therapy for OSAS for underserved communities. Uncovering commonalities in other diseases and the unique challenges within this population with accessing public healthcare can create steps towards improving the overall health as well as PAP compliance in an underserved community.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

Authors' contributions	TSB	MEW	JS
Research concept and design	✓	--	✓
Collection and/or assembly of data	✓	--	✓
Data analysis and interpretation	✓	✓	--
Writing the article	✓	--	--
Critical revision of the article	✓	✓	✓
Final approval of article	✓	✓	✓
Statistical analysis	✓	✓	--

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