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Acceptance and Compliance of Continuous Positive Airway Pressure in Patients with Obstructive Sleep Apnea: Local Population Survey

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ABSTRACT

Objectives: Continuous positive airway pressure (CPAP) compliance of > 4 hours per night has been considered acceptable to achieve clinical improvements in patients with obstructive sleep apnea (OSA). However, the factors determining CPAP adherence are unclear. This study aims to address the issue of acceptance and adherence to CPAP treatment in the Omani population and to determine the factors affecting adherence to CPAP. ***Methods***: This retrospective study included adult OSA patients who underwent polysomnography between January 2008 and December 2014 (n = 3046). Demographic information, Epworth Sleepiness Scale (ESS), apnea/hypopnea index (AHI), and desaturation events were collected from the sleep laboratory records. Subjects were grouped as CPAP users and CPAP non-users. CPAP users were divided into compliers (> 4 hours/night) and non-compliers (< 4 hours/night). Student's *t*-test was used to find differences in CPAP users and non-users, compliers, and gender differences in CPAP users. The association of CPAP compliers and non-compliers with age, gender, AHI, ESS, and comorbidities were assessed using the chi-square test. ***Results:*** Out of the 90.0% patients advised CPAP treatment, 34.7% came for regular CPAP follow-up. Total CPAP compliers were 59.3% (n = 274). The CPAP users had higher age, high ESS, baseline AHI, and more oxygen desaturation events than CPAP non-users ($p < 0.010$). Among the CPAP users, females were significantly older than males and had more oxygen desaturation events. CPAP compliers had significantly higher baseline AHI and more oxygen desaturation events. There was no association between CPAP compliance and age, gender, AHI, ESS, or comorbidities. ***Conclusions:*** CPAP users and compilers have severe OSA. CPAP acceptance and adherence are suboptimal and could not be predicted by age, gender, AHI, ESS, or comorbidities.

Obstructive sleep apnea (OSA) is a common sleep disorder affecting 3–9% of the general population and is a risk factor for hypertension, cardiovascular, neurological, and psychiatric diseases.[1,2] Daytime sleepiness (the main symptom of OSA) has predictable effects on decreasing work performance and is also a reason for car accidents.[3] Continuous positive airway pressure (CPAP) is the treatment of choice for patients with moderate and severe OSA.[4] It has been shown that CPAP improves nocturnal and daytime symptoms of OSA,[5] normalizes sleep structure, and reduces cardiovascular morbidity and mortality.[6,7] Although, CPAP is a highly effective treatment and the effect is directly related to treatment compliance.[8] However, CPAP acceptance and compliance remains a challenging issue. CPAP should be used throughout the patient's sleep duration but, in practice, this only occurs in a minority of subjects.

Several studies have indicated that compliance of > 4 hours/night has been considered acceptable to achieve clinical improvements, mainly daytime sleepiness.[8,9] Many factors can increase or decrease CPAP usage, which may include the severity of OSA, daytime sleepiness, age, sex, and comorbidities, in addition to settings of CPAP equipment, mainly the interface.[9,10] Previous studies that have addressed this subject have evaluated compliance over relatively short periods (one to six months). Long-term studies are few, and there is no study to date that has explored the CPAP acceptance and long-term compliance among the Arabic population or in the Arab Gulf region.

This study aims to determine how many patients with OSA recommended CPAP treatment accept

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the treatment and how many still use it after the initial trial. We also attempted to determine the factors for not accepting CPAP and abandoning the treatment in those who stopped CPAP after the trial period.

METHODS

This is a retrospective study. Our inclusion criteria were all adult patients age > 18 years who underwent full or split-night polysomnography from January 2008 to the end of 2014 in the sleep laboratory of Sultan Qaboos University Hospital (SQUH). SQUH is a tertiary care hospital in Oman. Adult patients with any comorbidity (e.g., cardiac or respiratory disease, thyroid abnormality, diabetes) were also included in the study. Pediatric patients (age < 18 years) were excluded from the study. All patients were clinically evaluated in the sleep medicine clinic before and after polysomnography. Patients who were recommended to use CPAP had at least one night of CPAP trial using the auto-titration technique. After the CPAP trial, subjects were subsequently seen in a sleep medicine clinic by the sleep physician who informed them of their diagnosis and the potential benefits of the treatment with CPAP. They were given a written prescription for CPAP, which included the titrated pressure, machine settings (auto/fixed), and the type of mask. Patients were asked to purchase their machines and accessories privately or to procure through donations since it is not covered by the local health system. Sleep technologists in the CPAP clinic gave basic education about CPAP use to patients. Follow-up appointment of patients were arrange in the CPAP clinic at least one month after initial treatment and at regular intervals thereafter. CPAP machine software gives the use of CPAP as the number of hours per night of sleep using CPAP. The compliance was calculated using this information.

Data were collected from the hospital information system and sleep laboratory records. Demographic data (age and gender), relevant clinical information regarding comorbidities (like cardiac or respiratory diseases, thyroid abnormalities, diabetes, and hypertension), and nocturnal symptoms were collected. Daytime sleepiness was assessed by asking patients to fill the Epworth Sleepiness Scale (ESS). Sleep laboratory reports provided apnea/hypopnea index (AHI) and desaturation index. The CPAP

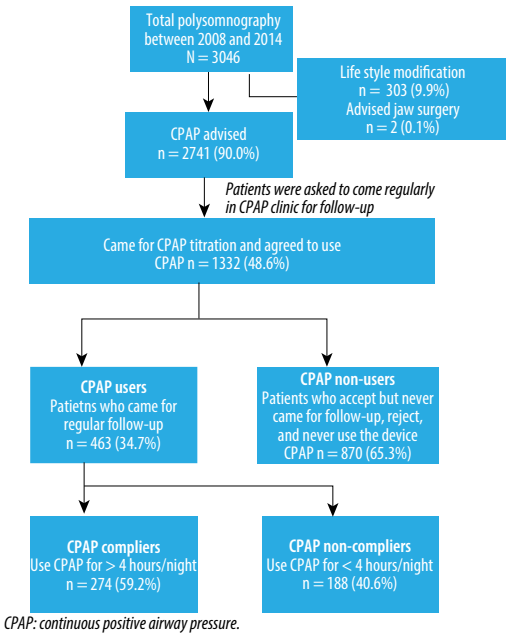

Figure 1: Flow chart of patient selection.

compliance and mask fitting were obtained from records of regular visits to the CPAP clinic.

The study was approved by the local ethical committee of the College of Medicine and Health Sciences, Sultan Qaboos University, Muscat, Oman (Ethical Approval no- MREC#469). Data were compiled and analyzed using SPSS (IBM Corp. Released 2015. IBM SPSS Statistics for Windows, Version 23.0. Armonk, NY: IBM Corp.). The outcome (dependent or response) variables were studied for their normal distribution using the Kolmogorov-Smirnov test. Parametric data were expressed as mean±standard deviation. A p-value < 0.050 was considered statistically significant.

Subjects were grouped as CPAP users and CPAP non-users based on the first week (trial week) of CPAP usage history and their regular follow-up in the CPAP clinic. Patients who accepted CPAP treatment and came for regular follow-up in the CPAP clinic are called CPAP users. The CPAP non-user patients were those who rejected the CPAP therapy at the time of titration, patients who did not use the device during the trial week, and also patients who accepted CPAP but never came for follow-up in the CPAP clinic.

CPAP users were further divided based on compliance. Those who used CPAP for > 4 hours/night were called CPAP compliers, and those who used CPAP for < 4 hours/night were called CPAP non-compliers. Polysomnography parameters for

Table 1: Differences in CPAP users and CPAP non-users.

Variables	CPAP user* n = 462	CPAP non-user# n = 810	*p*-value
Age, years	48.7 ± 13.1	46.2 ± 14.6	0.003
AHI pre-CPAP	48.6 ± 31.8	31.95 ± 32.8	< 0.001
AHI when on CPAP**	5.7 ± 5.4	-	-
Oxygen desaturation events, n	112.3 ± 139.0	71.1 ± 127.2	< 0.001
ESS	10.9 ± 5.3	10.1 ± 4.9	0.028

Data presented as mean±standard deviation.
CPAP: continuous positive airway pressure; AHI: apnea/hypopnea index; ESS: Epworth Sleepiness Scale.
**CPAP user: patients who accepted CPAP treatment and came for regular follow-up in the CPAP clinic.*
#CPAP non-user: patients who rejected the CPAP therapy at the time of titration, patients who did not use the device during the trial week, and patients who accepted CPAP but never came for follow-up in the CPAP clinic.
***This data is unavailable for CPAP non-user group.*

CPAP users and non-users, and gender differences among CPAP users and between CPAP compliers were tested using the Student's *t*-test. Age and gender-adjusted linear regression was performed for hours of compliance as the dependent variable and baseline AHI, oxygen desaturation events, ESS, and comorbidities as independent variables. The association of CPAP compliers and non-compliers with age, gender, AHI, ESS, and comorbidities were assessed using the chi-square test. Age was categorized based on quartiles for this data as 20–36 years, 37–47 years, and > 47 years. The AHI was dichotomized to < and > 5. The ESS was categorized as < and > 11.

RESULTS

All patients (n = 3046) patients who underwent overnight polysomnography from 2008 to 2014 were screened for the study. Out of this, 90.0% of patients (n = 2741) were advised CPAP treatment [Figure 1]. The remaining 10.0% either did not need CPAP treatment or were advised lifestyle modifications. Approximately 0.1% of patients were referred for corrective jaw surgery. Out of those who were advised to use CPAP, 48.6% (n = 1332) came for CPAP titration and agreed to use CPAP. Out of those who agreed to use CPAP, only 34.7% (n = 462) came for CPAP follow-up regularly and were considered CPAP users. The remaining patients were called CPAP non-users (n = 870) and constituted patients were those who rejected the CPAP therapy at the time of titration (n = 12), patients who did not use the device during the trial week (n = 4), and patients who accepted CPAP but never came for follow-up in the clinic (n = 854). In the CPAP non-user group, data for 60 patients was not available due to technical difficulties; thus, total subjects in CPAP non-user group was 810. Out of the CPAP users, the CPAP compilers are the patients who used CPAP for > 4 hours/night (n = 274; 59.2%) and the rest (n = 188) used CPAP for < 4 hours/night and are called CPAP non-compliers [Figure 1].

The CPAP users had a significantly higher age, high baseline AHI, more oxygen desaturation events, and higher ESS compared with CPAP non-

Table 2: Gender differences in patients who use CPAP.

Variables	Male n = 296	Female n = 166	*p*-value
Age, years	45.2 ± 12.9	55.0 ± 11.0	< 0.001
AHI pre-CPAP	46.6 ± 29.3	52.2 ± 35.7	0.073
AHI when on CPAP	6.4 ± 5.7	2.75 ± 1.8	0.229
Oxygen desaturation events, n	98.2 ± 126.3	137.4 ± 156.4	0.006
ESS	11.0 ± 5.5	10.8 ± 5.0	0.762
Weekly compliance	4.0 ± 1.9	4.0 ± 1.8	0.667

Data presented as mean±standard deviation.
CPAP: continuous positive airway pressure; AHI: apnea/hypopnea index; ESS: Epworth sleepiness scale.

Table 3: Difference in CPAP compliers (use of CPAP for > 4 hours/night) and CPAP non-compliers (use of CPAP for < 4 hours/night).

Variables	CPAP compliers n = 274	CPAP non-compliers n = 188	*p*-value
Age, years	49.6 ± 12.8	47.4 ± 13.4	0.081
AHI pre-CPAP	51.1 ± 33.6	44.9 ± 28.7	0.041
AHI when on CPAP	9.4 ± 13.3	5.3 ± 4.5	0.315
Oxygen desaturation events, n	125.1 ± 150.1	94.0 ± 119.1	0.022
ESS	10.6 ± 5.6	11.3 ± 4.9	0.295

Data presented as mean±standard deviation.
CPAP: continuous positive airway pressure; AHI: apnea/hypopnea index; ESS: Epworth Sleepiness Scale.

Table 4: Linear regression for CPAP use in hours/week.

Variables	β	*p*-value
Constant	1.314	< 0.001
Age, years	0.007	0.013
Gender (male)	-0.092	0.198
AHI pre-CPAP	0.002	0.138
Oxygen desaturation events, n	-0.0009	0.776
ESS	-0.003	0.647
Comorbidity	0.002	0.743

CPAP: continuous positive airway pressure; AHI: apnea/hypopnea index; ESS: Epworth sleepiness scale.

users ($p < 0.010$) [Table 1]. Among the CPAP users, females were significantly older than males and had significantly more oxygen desaturation events compared to males. There was no gender difference in baseline AHI, ESS, and night hours of use in CPAP users [Table 2].

Table 3 shows differences in CPAP compliers (use of CPAP > 4 hours/night) and CPAP non-compliers (use of CPAP < 4 hours/night). CPAP compliers had significantly higher baseline AHI and had significantly more oxygen desaturation events [Table 3]. There was no difference in age, AHI when on CPAP, and ESS between CPAP compliers and CPAP non-compliers.

The linear regression model explained that only 1.5% of variance was due to independent variables in the model. CPAP use was weakly explained by age only ($\beta = 0.007$; $p = 0.013$). The gender of the patient, baseline AHI, oxygen desaturation events, ESS, and presence of comorbidities did not predict CPAP compliance in hours [Table 4]. There was no association between CPAP compliance and age, gender, AHI, ESS, or comorbidities [Table 5].

Table 5: Association of CPAP compliance (< / > 4 hours/night) with age, gender, AHI, ESS, and comorbidities.

Variables	χ^2	*p*-value
Age, years	0.187	0.693
Gender (male)	1.317	0.518
AHI pre-CPAP	0.510	0.537
ESS	0.128	0.809
Comorbidity	1.104	0.310

CPAP: continuous positive airway pressure; AHI: apnea/hypopnea index; ESS: Epworth sleepiness scale.

DISCUSSION

Our study revealed that CPAP acceptance and compliance in this population is suboptimal, with only less than half of OSA patients accepted to use the treatment. It also showed that only one-third of the patients came for follow-up, which indicates that the remaining two-thirds may not have continued CPAP therapy. The above outcomes suggest that the CPAP treatment for sleep apnea is probably not well established in the local health system, and its acceptance is below the level reported by other studies.

A recent study showed that 70% of OSA patients used CPAP for more than five hours per night after three years of follow-up.[11] Earlier studies also showed good CPAP compliance with 81% of patients with sleep-disordered breathing using their CPAP machine for five years after starting the treatment, and 70% continuing to use it at 10 years.[12] Regionally, BaHammam et al,[13] reported that > 80% of Saudi patients with OSA continued to use CPAP 10 months after initiating therapy. However, other studies have reported different rates of CPAP

acceptance and compliance in different populations and our study may show some similarities with their findings. In a Chinese study, 33% of OSA patients never commenced CPAP therapy after undergoing CPAP titration, and only half of the study sample continued CPAP treatment.[14] In the USA, CPAP adherence was low in black subjects and lower socioeconomic residential areas[15] and was strongly associated with white race.[16] A Singaporean retrospective study showed that 50% of OSA patients continued CPAP therapy within five years.[17] A meta-analysis study indicated that the rate of CPAP adherence remains low over the last 20 years.[18] The meta-analysis also showed that CPAP adherence did not improve in recent years despite efforts towards behavioral intervention and patient coaching. This low rate of adherence is problematic and calls into question the concept of CPAP as the gold-standard of therapy for OSA.[18]

Many factors in this local population may hinder CPAP therapy. The local health system does not cover the cost of the both machine and the accessories, though it freely covers the clinical consultation and laboratory diagnosis. This might have caused some patients not to commence treatment, although our study did not elaborate on this factor.

One of the characteristics of CPAP users is that, compared to non-users, CPAP users have a severe form of OSA, higher AHI, and more desaturation events implying that patients with severe OSA tend to use CPAP compared to other patients with less severe OSA. Other studies also reported similar findings.[19,20] The CPAP adherent patients have higher ESS, AHI, and oxygen desaturation index (ODI) in a Danish population.[20] Although CPAP users had higher age, pre-CPAP AHI, and ESS, the same factors along with associated comorbidities, failed to predict the adherence to CPAP. There is inconsistency in the association of CPAP adherence with age, gender, race, disease severity, and nocturnal hypoxia.[8] ODI has been shown to be significantly correlated with long-term CPAP use.[10] But in the same study, age and ESS score did not correlate with five- and 10-year CPAP use.[10] Long-term CPAP use is related to disease severity and subjective sleepiness (ESS > 10).[12] A Southeast Asian study interviewed patients with OSA to understand the factors that affect CPAP treatment adherence. The study reported that OSA severity (AHI, ODI) and symptomatic improvement after CPAP were associated with better adherence. However, the presence of machine-related side effects lowered the adherence to CPAP while inconvenience, cost, and poor disease perception were reported as major barriers to accepting CPAP treatment.[21] The outcome of another qualitative study involving interviews of patients with OSA revealed an ambivalent or uncertain attitude towards acceptance and adherence to CPAP treatment. The study reported that "users of CPAP expressed ambivalent adherence, pondering whether they should stop using the device, and patients who rejected the CPAP expressed ambivalent nonadherence, wondering whether they should give the CPAP another chance". The same study also reported that adherence to CPAP might improve if there is a group where CPAP users meet adherent patients.[22] Overall, there is no consensus in the literature on which factors may predict adherence to CPAP treatment or may positively influence the acceptance of CPAP treatment.

The study has limitations that may limit its outcome. We could not interview patients who refused to use CPAP to understand reasons for abandoning or refusing the CPAP treatment. A long-term prospective study is required in this population to understand the attitude of people towards CPAP therapy.

CPAP therapy is sup-optimal in this population, and more work is needed to enhance acceptance and compliance of the treatment.

CONCLUSION

Our study indicated no difference between CPAP compliance in men and women, but the female CPAP users were older and had more severe disease compared to male users, and there is no difference in daytime sleepiness. These findings contradict with other studies, one which found that males are more compliant to CPAP compared to female patients,[23] and another showed no gender difference.[14] It is important to mention that regression model and chi-square analysis indicated that age, sex, AHI, and comorbidities did not predict the acceptance or adherence to CPAP, and patients who continue to use CPAP did so probably based on their perception of the treatment, and that could open a window for further studies looking into the problem from another perspective. Future studies in our local population may focus on attitude of

OSA patients towards CPAP therapy and the socioeconomic burden of starting CPAP with no public financial support. This may shed more light on why individual patients accept the treatment but not others.

Disclosure
The authors declared no conflicts of interest. No funding was received for this study.

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