

# A comparative cloud-based view of adherence data over 1 year of CPAP versus APAP uses in OSA patients: Adherence depends on PAP device

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## ABSTRACT

**Introduction:** Compliance or adherence with positive airway pressure (PAP) therapy is a major issue in obstructive sleep apnea (OSA). The telemonitoring gives an opportunity to track a group of patients on cloud-based devices. In this study, we followed up patients with this cloud-based method for more than a year and followed up two different cohorts who are on continuous PAP (CPAP) and auto adjusting PAP (APAP) devices. The main objective was to judge whether one device scores over the other. **Methods:** This was a retrospective study. We included 60 patients in the CPAP group and 80 patients in the APAP group in the study who are using the device for 1 year or more; they all were on cloud-based devices, and for them, we had data of completed 1 year at least. The data were reviewed periodically for compliance, AHI (Apnea-Hypopnea Index), and leak and compared. **Results:** Both the groups were matched in terms of age, BMI, and AHI. Adherence at 365 days was significantly more ( $P < 0.001$ ) for CPAP than APAP. Overall adherence was not lesser than 60% for CPAP in any patient. The mean AHI was 1.48 in CPAP group and 2.30 in APAP group. When we measured the leak in CPAP versus APAP group, it was 0.53 liter/minute more in CPAP group than in APAP group, but it was statistically non-significant ( $P = 0.8553$ ). The mean pressure level between APAP and CPAP was 11.11 cmH<sub>2</sub>O in CPAP group and 11.62 cm H<sub>2</sub>O in APAP group, and it was again statistically non-significant ( $P = 0.1960$ ). CPAP group used the machine 5.77 hours average, while APAP group used it for 4.51 hours average. **Conclusion:** CPAP adherence at 1 year was better over APAP in this study, which has a large cost implication.

**KEY WORDS:** Adherence, APAP, cloud-based device, CPAP

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## INTRODUCTION

Positive airway pressure (PAP) devices are the cornerstone of obstructive sleep apnea (OSA) treatment. PAP therapy may be prescribed either through continuous positive airway pressure (CPAP) devices or through auto adjusting

positive airway pressure (APAP) devices. Though initially APAP was developed as a titrating device, soon, it got application as a therapeutic device in uncomplicated OSA. But tracking adherence is an important issue in both

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kinds of devices. The compliance tracking can be done though either a traditional method or reviewing the data card storage of the PAP devices or through cloud-based methods. A cloud-based system is a broad term for anything that involves the delivery of hosted services via the Internet. So, the provider can monitor and access the machine if permission had been granted by the user. Instead of the users coming to the provider with the PAP machine for checking adherence and troubleshooting, the same job can be done online, thus saving efforts and time. Cloud-based telemonitoring PAP devices offer an opportunity for proactive monitoring and prompt interventions related to PAP troubleshooting.

But compliance or adherence with PAP therapy is a major issue. A 10-year adherence data to CPAP has shown 31% dropout rate specially in the first year of therapy.<sup>[1]</sup> Studies have shown that cloud-based methods, as compared to standard methods of PAP monitoring, reduce the termination rate of the PAP therapy and improve the overall compliance.<sup>[2,3]</sup>

The telemonitoring also gives an opportunity to track a group of patients on cloud-based devices. Such monitoring would otherwise be difficult as the subject needs regular review with data card reports. We used this opportunity to observe a cohort of patients on PAP therapy. Most of the previous studies used data card retrieval, and long duration follow-up studies are not available. In this study, we followed up patients with this cloud-based method for more than a year and followed up two different cohorts who are on CPAP and APAP devices.

The main objective was to judge whether one device scores over the other.

The other objectives of the study were to compare the adherence and daily uses of APAP and CPAP and to compare the pressure required and Apnea-Hypopnea Index (AHI) with these two devices.

## MATERIAL AND METHODS

This retrospective study was carried out in a sleep centre where many patients were being referred for installation of PAP devices. The choice of either CPAP or APAP for regular use was determined by both input of referring physicians and the patient's choice; thus, the centre had no role in choosing the device. Initially, we looked at a record of 527 patients, who came to us for a PAP device with a diagnosis of OSA. They all consulted for initial use of the device on rental basis

before purchasing the instrument. Among them, 375 patients were prescribed cloud-based devices. APAP was prescribed in 306 patients and CPAP in 69 patients. Rest 152 patients were prescribed non-cloud-based devices. Among 306 patients initially prescribed cloud-based APAP, 117 did not comply further and dropped. Similarly, among 69 patients on cloud-based CPAP devices, two patients dropped. We included 60 patients in the CPAP group and 80 patients in the APAP group in the study who are using the device for 1 year or more (maximum 900 day and minimum 365 days); they all were on cloud-based devices, and for them, we had data of completed 1 year at least [Figure 1]. The adherence data were shared by the centre periodically with referring physicians, but no direct communication was not made with the users. The follow-up schedule varied between the consulting physicians.

A consent was taken from all patients who shared their data over cloud, and strict anonymity was maintained.

## RESULTS

A total of 140 patients were recruited for the study, 60 in CPAP group and 80 in APAP group. Initially, both the groups were matched in terms of age, BMI, and AHI [Table 1]. But the mean desaturation index (DI) was 62.19 in CPAP group and 49.69 in APAP group. The mean nadir SpO<sub>2</sub> was 62% in CPAP group and 49.69% in APAP group. The DI and nadir SpO<sub>2</sub> were significantly lower in CPAP group than in the APAP group.

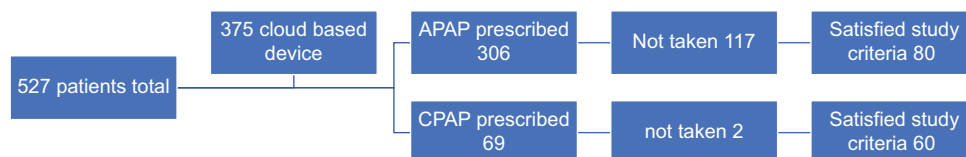
The adherence to CPAP and APAP was measured at 30 days, at 180 days, and at 365 days [Figure 2].

The Box and Whisker plot showed that CPAP adherence was better than APAP in all three-time end points. Compliance or adherence at 365 days was 87.55% in CPAP group and 67.81% in APAP group. Adherence at 365 days was significantly more ( $P < 0.001$ ) for CPAP than APAP.

When compliance at the 365<sup>th</sup> day of each patient was plotted, it showed that overall compliance/

**Table 1: Comparison of the two groups**

Parameter	CPAP	APAP	<i>P</i>	Cohen's <i>d</i>
Age in Years (Mean)	53.2	52.1129	0.9667	
BMI (Mean)	32.00366	31.407903	0.4847	
AHI (Mean)	54.03666	48.248387	0.0937	
Desat Index (Mean)	62.19	49.693548	0.0021	0.559644
Nadir SpO <sub>2</sub> (Mean)	67.083333	74.322580	0.0034	0.540768



**Figure 1: Flow diagram of inclusion of patients**

adherence was not lesser than 60% for CPAP in any patient [Figure 3].

The mean AHI was 1.48 in CPAP group and 2.30 in APAP group. AHIs at 365 days were less for CPAP group than for the APAP group, and it was statistically significant ( $P = 0.0161$ ). There were more outliers in APAP group than in the CPAP group [Figure 4].

When we measured the leak in CPAP versus APAP group, it was 0.53 liter/minute more in CPAP group than in APAP group, but it was statistically non-significant ( $P = 0.8553$ ) [Figure 5].

If we consider the mean pressure level between APAP and CPAP, it was 11.11 cmH<sub>2</sub>O in CPAP group and 11.62 cm H<sub>2</sub>O in APAP group, and it was again statistically non-significant ( $P = 0.1960$ ) [Figure 6]. This is in contrary to the popular belief that APAP provides lower mean pressure than CPAP.

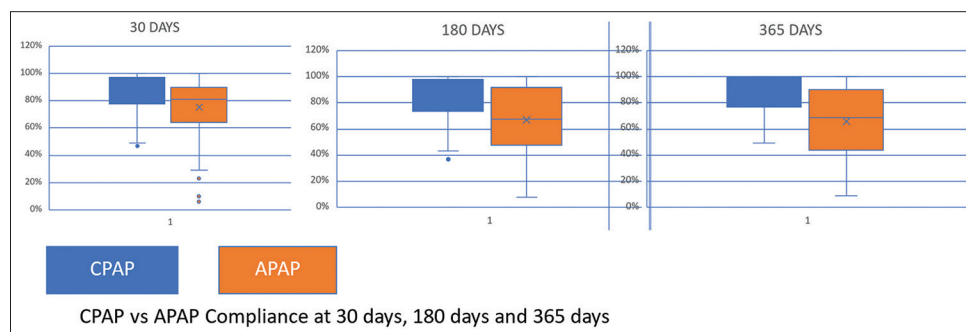
We have also compared mean daily uses of CPAP versus APAP over 1 year. CPAP group used the machine 5.77 hours average, while APAP group used it for 4.51 hours average. CPAP patients used the machine 72 minutes more than the APAP machine, and it was statistically significant ( $P < 0.001$ , Cohens' d was 0.8656) [Figure 7]. This was again in contrary to previous studies which mostly compared maximum 12 weeks data for CPAP versus APAP and inferred that CPAP uses were 13 minutes less than the APAP.

## DISCUSSION

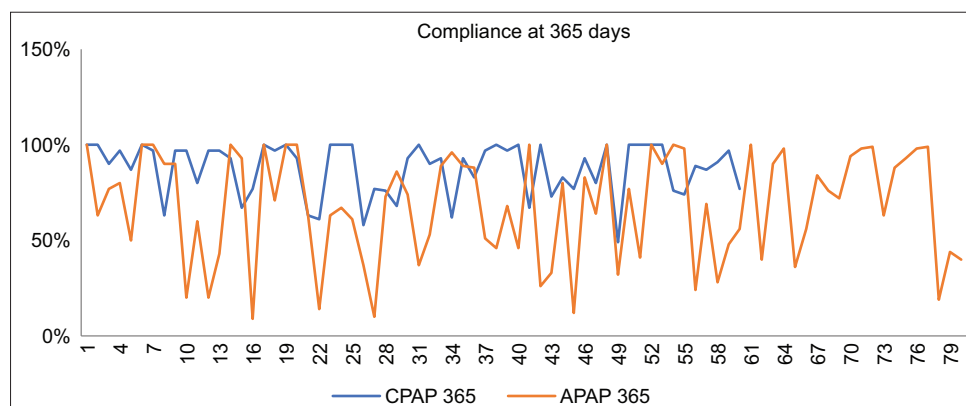
This is perhaps the first study to describe the use of cloud-based CPAP and APAP over 1 year. Other available studies were mostly done for 3 weeks to 9 months.<sup>[4]</sup> One paediatric study was done with 27 patients with 1 year of follow-up comparing adherence between CPAP and APAP and found no difference.<sup>[5]</sup> The larger cohort of patients in this study ensured that a valid comparison between the two groups was possible. Both groups were matched in terms of age, BMI, and AHI. So, comparison was done on two similar subsets. However, desaturation index and nadir oxygen saturation were lower in CPAP group, suggesting probably a sicker group in the CPAP cohort, in terms of nocturnal oxygen saturation.

The CPAP adherence always scored better over APAP in the present study. Interestingly, CPAP adherence in any patient was never less than 60% at any point of time during the study period. The AHI was well controlled in both groups, but numerically, AHI control was better in CPAP group than in APAP group and statistically significant. There were more outliers in APAP group in terms of AHI, suggesting a few patients with APAP had increased AHI and the group was not as homogeneous as CPAP group in terms of AHI control. This was in accordance to previous findings where the AHI control was similar across both devices.<sup>[6-10]</sup>

Leak is a major issue in PAP devices. In this study, leak was similar in both devices, although CPAP groups



**Figure 2:** Adherence check at 30 days, 180 days, and 365 days by Box and Whisker plots



**Figure 3:** Percentage of adherence between CPAP and APAP

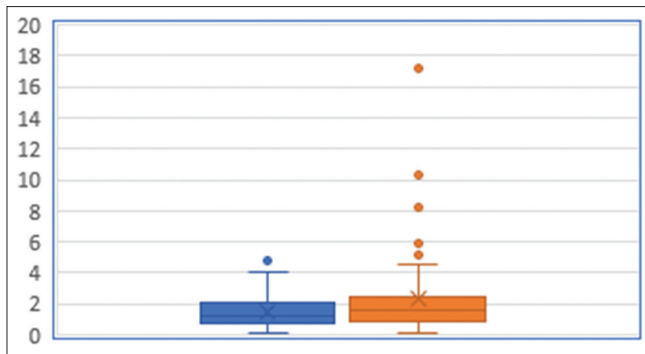


Figure 4: AHI at 365 days with CPAP vs APAP

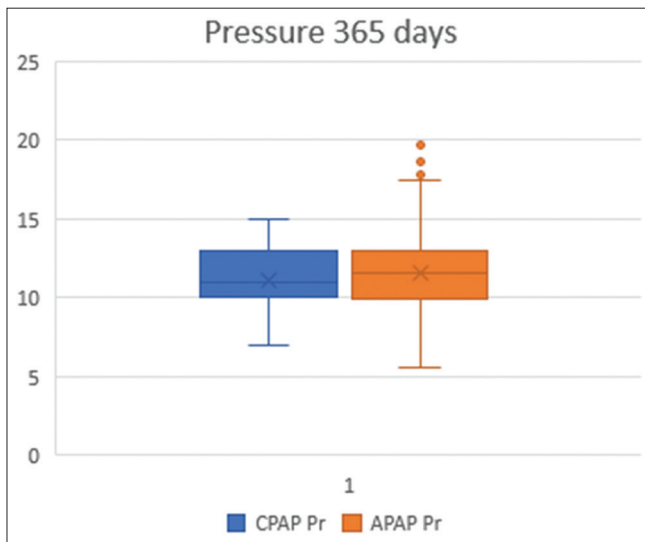


Figure 6: 95<sup>th</sup> percentile pressure with CPAP vs APAP

had more outliers than APAP group, suggesting the heterogeneity in terms of leak in CPAP cohort. We could not find any study which compared leak between APAP and CPAP. But one study showed the adherence with CPAP did not depend on leak.<sup>[11]</sup> In the present study, we had similar findings and leak actually had no effects on overall adherence.

The mean pressures offered by CPAP and APAP were similar and were approximately 11 cm H<sub>2</sub>O in both groups. This is in contrary to the popular belief that APAP provides lower mean effective pressure than CPAP. One metaanalysis showed that APAP reduced the mean applied pressure by 2.2 cm H<sub>2</sub>O across the nights.<sup>[12]</sup> But most of the studies included in metaanalysis were of short duration and the maximum follow-up time was 12 weeks.

We have also compared mean daily uses of CPAP versus APAP over 1 year. The mean daily uses were 72 minutes more in CPAP group than in the APAP group. This result was in contrast to a Cochrane review which showed APAP use was 13 minutes more than daily CPAP use when compared for a 6 weeks duration.<sup>[13]</sup> The situation probably changes with long-term use. Our data showed

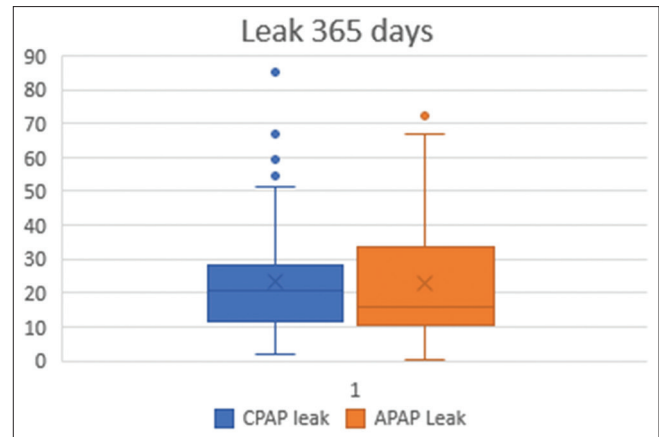


Figure 5: Leak with CPAP vs APAP

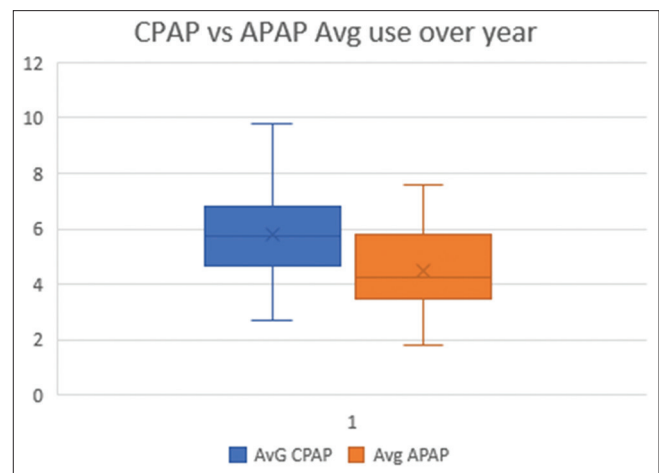


Figure 7: Daily average use of CPAP vs APAP

that over 1 year CPAP use was significantly more than the APAP.

But why we got such differences between CPAP and APAP uses? One potential advantage of APAP over CPAP is the ability to automatically adjust therapeutic pressures as OSA severity changes with weight fluctuations, nighttime alcohol consumption, body position, sleep stages, and changes in upper airway anatomy. APAP also has some disadvantages for some patients, including sleep disruption from pressure fluctuations<sup>[14]</sup> and the return of sleep-disordered breathing events when the PAP level is lowered by the device algorithms.<sup>[15]</sup> A stable pressure throughout night probably provides more stable sleep and thus more use and improved adherence. Probably, this was the reason for better adherence with CPAP. So, based on the study, we can hypothesise that CPAP would be a better modality in persons with low arousal threshold. The study has a large implication in terms of cost saving as CPAP comes with much lower prices than APAP (almost half the price) and cost is the most important decisive factor in treatment of OSA in low- and middle-income countries.



There were several weaknesses of the study. Being a retrospective study, it comes with inherent biases. The selection of devices was dependent on prescriber. Here, only those patients were selected who used the device for at least 1 year and also shared their data over cloud; this was being a compliant group overall. The sleep parameters and quality of life data were not incorporated in study as those data were unavailable for all recruited subjects. Thus, whether the improved adherence in CPAP group also translates to better sleep and better life was unknown. A prospective RCT with inclusion of sleep parameters and quality of life data would be more meaningful. Additionally, the control of comorbid conditions with improved adherence may give more meaningful insight.

## CONCLUSIONS

There were several conclusions from this study. CPAP adherence was significantly better at 1 year than APAP. AHI control at 1 year was significantly better in CPAP group than in APAP group. The mean pressures between the CPAP and APAP groups were not different. The leak between the CPAP and APAP groups was not different. Patients on CPAP used the machine 72 minutes more daily than the APAP group, and it was statistically significant. So, CPAP scored better over APAP in this study.

## Abbreviations

PAP	= Positive Airway Pressure
OSA	= Obstructive Sleep Apnea
CPAP	= Continuous Positive Airway Pressure
APAP	= Auto adjusting Positive Airway Pressure
AHI	= Apnea-Hypopnea Index
BMI	= Body Mass Index
DI	= Desaturation Index
SpO2	= Oxygen Saturation
RCT	= Randomised Control Trial.

## Informed consent

All patients included within Institute of Sleep Sciences (CMRI Hospital) data base have an informed consent that mentions that their anonymized data can be used for the purposes of research. Hence every patient included in the study retrospectively had informed consent (as above).

## Ethics approval

all patients included in our study were from afore mentioned data base and data was collected retrospectively. There was no intervention or even an interaction with patients as a part of the study. Given that this was a retrospective study based on our existing database, no ethics approval was sought for the study.

## Data availability

I confirm I have included a data availability statement in my main manuscript file. Data Availability Statement: Data will be made available on reasonable request.

## Highlights

1. Compliance with CPAP or APAP is low in OSA. Whether CPAP or APAP scores over other, when used with telemonitoring was sought in this study.
2. The study shows CPAP adherence was better over APAP at 1-year follow-up in two similar cohorts. This has a cost implication in terms of OSA treatment.

## Financial support and sponsorship

Nil.

## Conflicts of interest

There are no conflicts of interest.

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