# Effective Compliance during the First 3 Months of Continuous Positive Airway Pressure

## A European Prospective Study of 121 Patients

**JEAN LOUIS PÉPIN, JEAN KRIEGER, DANIEL RODENSTEIN, ANDRÉ CORNETTE, EMILIA SFORZA, PIERRE DELGUSTE, CHRYSTÈLE DESCHAUX, VÉRONIQUE GRILLIER, and PATRICK LÉVY**

Department of Respiratory Medicine and Sleep Laboratory, University Hospital, Grenoble, France; Sleep Disorders Unit, University Hospital, Strasbourg, France; Respiratory Department, University Hospital of Nancy, Vandoeuvre-les-Nancy, France; Respiratory Department, Cliniques Universitaires St-Luc, Université Catholique de Louvain, Brussels, Belgium; Nellcor Puritan Bennett FD, Nancy-les-Villers, France; and PRETA Laboratory, UMR CNRS 5525, Department of Physiology, Faculty of Medicine, Joseph Fourier University, Grenoble, France

**Effective compliance (time spent at the effective pressure) with nasal CPAP in obstructive sleep apnea has been reported to be poor. The aim of our study was to evaluate effective compliance in a large European multicenter study. One hundred twenty-one consecutive newly treated patients (initial apnea–hypopnea index [AHI] = 62.0 ± 29.5/h, AHI under CPAP = 6.4 ± 8.1/h, CPAP pressure = 8.7 ± 2.6 cm $H_2O$, BMI = 33.1 ± 6.8 kg/$m^2$) were randomly allocated to a group with ($MC^+$) (n = 58) or without ($MC^-$) (n = 63) a control unit measuring effective compliance at 1, 2, and 3 mo, which was compared with the built-in time counter data. $MC^+$ data were 94 ± 10, 98 ± 5, and 96 ± 9% of counter data at 1, 2, and 3 mo, respectively. Using criteria of regular use already reported in the literature (at least 4 h of nCPAP per day of use and nCPAP administered more than 70% of the days) we found 77, 82, and 79% compliant patients at 1, 2, and 3 mo, respectively, 79% of the patients meeting these criteria each month. Although there were no pulmonary functions or polysomnographic differences between the two subgroups, the compliant patients did report a greater improvement in minor symptoms. We found a close correlation between effective use of CPAP and the machine run time. The main result of our study was a higher effective compliance than previously reported, approximately 80% of the patients being regular users versus 46% in a previously published study. This may result from different technical and medical follow-up.** Pépin JL, Krieger J, Rodenstein D, Cornette A, Sforza E, Delguste P, Deschaux C, Grillier V, Lévy P. Effective compliance during the first 3 months of continuous positive airway pressure: a European prospective study of 121 patients.

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Nasal continuous positive airway pressure (nCPAP) is undoubtedly the first-line therapy in obstructive sleep apnea syndrome (OSAS) (1). Although it is a highly effective treatment, the success of CPAP is dependent on regular use and it has been demonstrated that intermittent users are at risk of negative sequelae (2). Thus compliance is one major aspect regarding CPAP therapy.

Compliance rates with nCPAP were initially found to range from 65 to 80% (3–8) with 8–15% of patients refusing this treatment after a single night's use in the laboratory (4, 6). These data were obtained either from patient questionnaires (subjective compliance), or built-in time counters (objective compliance). Other data, mainly from the United States (9–11), have indicated poor effective compliance (time spent at the effective pressure). Only 46% of the patients used the therapy for at least 4 h on 70% of the days (9). In Europe, the modalities of prescription and the medical and technical follow-up differ from those in the United States, and this can affect the effective compliance. Thus, it appears that there is a discrepancy between European and U.S. data. Therefore, in four European sleep laboratories, we have studied effective compliance in 121 newly diagnosed and treated patients during a 3-mo prospective study. Moreover, we have related compliance to the sleeping habits before and during therapy, as this determines critically the duration of use of nCPAP.

## METHODS

One hundred twenty-one consecutive newly diagnosed patients with OSAS were recruited from four centers in France and Belgium over a 6-mo period. The study was approved by the local medical ethics committee and informed consent was obtained. The patients had all been referred to the sleep laboratories with suspected OSAS. The therapy decision was made by the physician, independent of whether the patient would be involved in the protocol. Exclusion criteria included age greater than 75 yr and the presence of chronic respiratory failure.

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Correspondence and requests for reprints should be addressed to Prof. P. Lévy, Unité Sommeil et Respiration, Département de Pneumologie, CHU de Grenoble, BP 217 X, 38043 Grenoble, France. E-mail: Patrick.levy@imag.fr

**TABLE 1**

**PATIENT CHARACTERISTICS AND COMPARISON OF $MC^+$ AND $MC^-$**

| | $MC^-$ ($n = 63$) | $MC^+$ ($n = 58$) | p Value |
|---|---|---|---|
| Age, yr | 53 ± 11 | 54 ± 10 | 0.593 |
| Sex, M/F | 57/6 | 53/5 | |
| BMI, kg/m$^2$ | 33.7 ± 6 | 32.5 ± 7 | 0.354 |
| AHI diagnosis, no./h | 65.6 ± 33 | 57.8 ± 26 | 0.158 |
| Mean $Sa_{O_2}$ diagnosis, % | 90.2 ± 6 | 91 ± 5 | 0.567 |
| Mean P CPAP, cm $H_2O$ | 8.7 ± 3 | 8.8 ± 3 | 0.878 |
| AHI under CPAP, no./h | 6.5 ± 8 | 6.3 ± 8 | 0.915 |
| Mean $Sa_{O_2}$ CPAP, % | 93.6 ± 3 | 93.8 ± 4 | 0.789 |

*Definition of abbreviations*: AHI = number of apneas and hypopneas per hour of sleep; BMI = body mass index; $MC^+$ = group of patients with a control unit measuring mask pressure; $MC^-$ = group of patients without the control unit.

All of the patients completed a pretreatment questionnaire assessing clinical presentation, sleep habits, and social and professional status. Anthropometric data were also collected. Spirometry and blood gas determinations were performed. A sleep diary was filled out for 3 wk before treatment and during the 3 mo of therapy.

All patients underwent full polysomnography using standard methods (12), and all had an apnea hypopnea index (AHI) (apneas plus hypopneas per hour slept) of more than 10 per hour.

The pressure setting of each machine was adjusted to a level sufficient to abolish apneas and restore a correct sleep quality as assessed by polysomnography. All of the patients were equipped with the same device (REM+; Sefam-NPB, Nancy, France) in order to standardize technical aspects such as measurement of mask pressure, leak compensations, and noise level.

Clinical status, patient compliance, perception of benefits, and side effects were assessed at each month during the 3-mo period of the study. All of the patients had the usual in-hospital training during the first 3 d of treatment and strong back-up support from the home care association, especially during the first weeks of treatment. In-hospital training was essentially devoted to education and mask adaptation in order to achieve the highest comfort and to minimize air leaks. Patients were encouraged to telephone the hospital for help if any medical problem or side effect occurred. The only difference between usual practice and the present protocol was the addition of the two visits at 2 and 3 mo.

### Assessment of Compliance

Both objective (clock-time counter) and effective compliance data were collected.

Regarding effective compliance, the patients were randomly allocated to groups with ($MC^+$) or without ($MC^-$) a control unit measuring mask pressure (effective duration of treatment equals time spent at the effective pressure of treatment ± 1 cm $H_2O$) ($MC^+$; Sefam, Villers-les-Nancy, France). As all of these patients were new to treatment, the presence of the control unit should presumably not make any difference. However, the two groups, $MC^+$ and $MC^-$ were compared.

In distinguishing compliant and noncompliant patients, we have used two different definitions. As defined by Kribbs and coworkers (9), patients were considered compliant when using their nCPAP device for more than 5 d/wk and for more than 4 h/d of use. We also used a more restrictive definition of compliance, requiring more than 5 d/wk and more than 4 h/d of use as a mean, that is, including the days without CPAP. To compare our data with others, we have calculated both.

### Statistical Analysis

Unpaired *t* tests or Mann–Whitney tests were used to compare quantitative variables. The chi-square test was used for noncontinuous variables. Analysis of variance (ANOVA) was used for repeated measures.

## RESULTS

### Patient Characteristics

Patient characteristics at inclusion (n = 121) are shown in Table 1, which compares the $MC^+$ and $MC^-$ groups. Most of the patients had moderate to severe OSAS (AHI of more than 50 per hour of sleep) and were obese (BMI of $\sim$ 33 kg/m$^2$). The comparison of the groups did not show any difference in anthropometric characteristics or the AHI at diagnosis and under nCPAP treatment.

### Comparison of Treatment Centers

Variance analysis showed significant differences between centers in terms of $Pa_{O_2}$, $Pa_{CO_2}$, mean $Sa_{O_2}$ at diagnosis, nCPAP, mean $Sa_{O_2}$ under nCPAP, and AHI under nCPAP. In contrast, there were no differences in terms of sex ratio, age, BMI, $FEV_1$, VC, or diagnostic AHI (Table 2).

Regarding objective compliance, there was no significant difference between centers at 1 and 2 mo, but the compliance was significantly different at 3 mo, ranging from 261 to 380 min (p = 0.0082) (Table 2).

### Inclusion and Follow-up

Seven patients were excluded from the study. Four were intolerant of treatment, two considered the protocol to be too con-

**TABLE 2**

**COMPARISON OF TREATMENT CENTERS: PATIENT CHARACTERISTICS, POLYGRAPHIC DATA, AND MEAN DAILY USE OF nCPAP**

| | Brussels | Grenoble | Nancy | Strasbourg | p Value |
|---|---|---|---|---|---|
| Age, yr | 51 ± 11 | 55 ± 11 | 53 ± 10 | 56 ± 7 | NS |
| Sex, M/F | 30/0 | 28/3 | 27/3 | 25/5 | NS |
| BMI, kg/m$^2$ | 33.8 ± 7.4 | 31.2 ± 6.3 | 35.3 ± 7.3 | 32.3 ± 5.5 | NS |
| $Pa_{O_2}$, mm Hg | 83 ± 13 | 74 ± 10 | 70 ± 9 | 75 ± 10 | 0.0001 |
| $Pa_{CO_2}$, mm Hg | 37 ± 5 | 41 ± 3 | 39 ± 4 | 41 ± 5 | 0.0004 |
| $FEV_1$, ml | 3,264 ± 559 | 3,139 ± 1,065 | 2,991 ± 969 | 3,104 ± 804 | NS |
| VC, ml | 4,314 ± 660 | 4,069 ± 1,278 | 3,767 ± 1,124 | 4,428 ± 1,077 | NS |
| AHI diagnosis, no./h | 56.3 ± 20.9 | 56.6 ± 31.4 | 69.1 ± 33.7 | 65.1 ± 28.9 | NS |
| Mean $Sa_{O_2}$ diagnosis, % | 90.2 ± 4.6 | 90.8 ± 4.4 | 87.7 ± 7.7 | 93.2 ± 3.9 | 0.0023 |
| Mean pressure, cm $H_2O$ | 7.7 ± 2.6 | 10.4 ± 2.1 | 8.6 ± 2.4 | 8.1 ± 2.4 | 0.0002 |
| AHI under CPAP, no./h | 9.9 ± 10 | 11.3 ± 8.8 | 0.5 ± 1.9 | 4.7 ± 5.0 | < 0.0000 |
| Mean $Sa_{O_2}$ CPAP, % | 94.8 ± 2.4 | 95.6 ± 1.4 | 90.6 ± 4.7 | 93.8 ± 2.2 | < 0.0000 |
| CPAP use at 1 mo, min | 283 ± 129 | 348 ± 130 | 360 ± 110 | 311 ± 116 | 0.0741 |
| CPAP use at 2 mo, min | 304 ± 120 | 361 ± 127 | 369 ± 111 | 302 ± 134 | 0.0791 |
| CPAP use at 3 mo, min | 261 ± 125 | 322 ± 141 | 380 ± 93 | 320 ± 128 | 0.0082 |

*Definition of abbreviations*: AHI = number of apneas and hypopneas per hour of sleep; BMI = body mass index; CPAP use = duration of daily use of nCPAP as measured by clock-time counter.

**TABLE 3**

**OBJECTIVE COMPLIANCE: COMPARISON OF $MC^+$ AND $MC^-$ GROUPS**

| Time Machine On (per day) | $MC^-$ | $MC^+$ | p Value |
|---|---|---|---|
| First month, min | 311 ± 136 | 339 ± 110 | 0.140 |
| Second month, min | 311 ± 134 | 356 ± 114 | 0.064 |
| Third month, min | 297 ± 134 | 343 ± 120 | 0.062 |

For abbreviation definitions, *see* Table 1.

**TABLE 5**

**PERCENTAGE OF COMPLIANT PATIENTS AT 1, 2, AND 3 mo**

| | Compliant Patients (K) | % | Compliant Patients (S) | % |
|---|---|---|---|---|
| First month | 40/52 | 77 | 37/52 | 71 |
| Second month | 42/51 | 82 | 39/51 | 76 |
| Third month | 44/56 | 79 | 42/56 | 75 |
| Consistent over 3 mo | 47/57 | 79 | 42/57 | 74 |

*Definition of abbreviations*: K = Kribbs criteria: > 5 d/wk and > 4 h/d of use; S = strict criteria: > 5 d/wk and > 4 h/d as a mean.

straining, and one had a change of nCPAP machine that did not allow use of the $MC^+$ unit. When comparing these seven patients with the rest, there was no difference in terms of clinical, functional, or polygraphic data except for VC (3,409 ± 582 versus 4,188 ± 1,090 ml, $p < 0.0353$) and mean nocturnal $Sa_{O_2}$ under nCPAP (91.5 ± 1.6 versus 93.8 ± 3.5%, $p < 0.0137$).

### Comparison of Objective Compliance between $MC^+$ and $MC^-$ Groups

The duration of use of nCPAP evaluated on the basis of clock counter measurement was high (mean equal to or greater than 5 h). The values in the $MC^+$ group tended to be higher, although the trend was not significant (Table 3).

### Comparison of Objective and Effective Compliance

In the $MC^+$ group, both effective and objective compliance data were available for comparison. Table 4 shows that the proportion of effective to objective compliance was 94, 98, and 96% at 1, 2, and 3 mo, respectively.

### Estimation of the Percentage of Compliant and Noncompliant Patients (Effective Compliance)

We have used both the criteria of Kribbs and coworkers (K) and our own criteria, which we considered more strict (S). The percentage of compliant patients at 1, 2, and 3 mo, using both criteria, is presented in Table 5. The percentage of compliant patients ranged from 71 to 82%.

### Comparison of Compliant and Noncompliant Patients

The two subgroups (using strict criteria, > 5 d/wk and a mean use of more than 4 h/d) had the following characteristics for the three cumulative months:

1. Compliant patients (effective compliance): n = 34 (74%), mean utilization = 361 ± 64 min, number of days per week = 6.7 ± 0.3
2. Noncompliant patients (effective compliance): n = 12 (26%), mean utilization = 166 ± 43 min, number of days per week = 4.8 ± 0.9

**TABLE 4**

**COMPARISON BETWEEN EFFECTIVE AND OBJECTIVE COMPLIANCE***

| | Time $MC^+$/Time Machine On | n |
|---|---|---|
| First month, min | 94 ± 10% | 52 |
| Second month, min | 98 ± 5% | 50 |
| Third month, min | 96 ± 9% | 54 |
| Average over 3 mo | 96 ± 5% | 44 |

* Time $MC^+$/time machine on = proportion of effective to objective compliance.

Both the percentage of compliant patients and the duration of use were established at 1 mo (Figure 1) and remained constant during the 3 mo of observation. In contrast, there was a nonsignificant decrease duration of use in the noncompliant subgroup, the mean values being, respectively, 168, 159, and 150 min at 1, 2, and 3 mo.

When comparing the compliant and noncompliant patients, we did not find any difference in terms of age, BMI, $Pa_{O_2}$, $Pa_{CO_2}$, $FEV_1$, VC, mean nocturnal $Sa_{O_2}$ and AHI at diagnosis, nCPAP, and mean nocturnal $Sa_{O_2}$ and AHI under nCPAP. There was no difference in side effects. The same percentage of patients described an improvement in snoring (82.4 versus 75%, p = 0.8) and daytime sleepiness (79.4 versus 83.3, p = 0.95) in the compliant and noncompliant subgroups, respectively. Conversely, compliant patients reported more often a significant reduction in nocturia (64.7 versus 25%, p = 0.02) and subjective sleep disruption (76.4 versus 41.7%, p = 0.02). Finally, the compliant patients usually tended to feel more refreshed at the end of the night (76.4 versus 50%, p = 0.09).

There was no difference in duration of use per night when comparing individual days of the week in the compliant subgroup. Regarding the noncompliant subgroup, although the variance analysis did not show a significant difference, there was a significant reduction on Saturday (204 ± 83 min) when compared with the mean values of Thursday (255 ± 69 min),

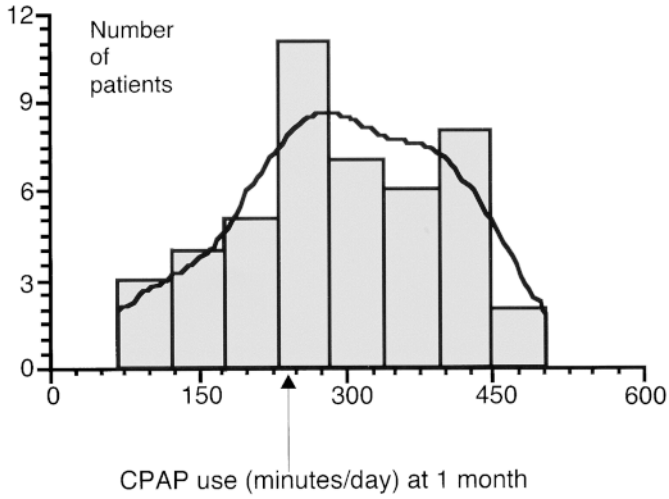


***Figure 1.*** Plot of distribution of nCPAP use (minutes per day) at 1 mo in the compliant and noncompliant subgroup of patients (n = 46). The arrow indicates the use of nCPAP, above which the patients are considered compliant. Note that the distribution of nCPAP use is normal.

Friday (257 ± 71 min), or Sunday (257 ± 73 min), these data being calculated only for the days when CPAP was used.

### Sleep Habits and Nasal CPAP Therapy

Of the 114 patients with full follow-up data, 47 had both clock-time counter data and home diaries for the different times of the study. These 47 individuals were not different from the rest of the population in terms of age, BMI, severity of disease, efficacy of treatment, and compliance. These 47 patients could be classified according to their mean total sleep time (TST). The limit was put at 8 h. Twenty-two individuals were thus considered "short sleepers" whereas 25 were considered "long sleepers." When comparing short and long sleepers, there was no difference in terms of age, BMI, AHI at the time of diagnosis and under nCPAP, and objective compliance data. Although the two groups of patients still had significant differences in sleep duration at 1, 2, and 3 mo, there was a significant reduction in sleep duration after 1 mo of treatment (496 ± 50 versus 531 ± 53 min, $p = 0.014$) that was maintained at 2 and 3 mo in the long sleeper group. In contrast, there was no change in the short sleeper group. The reduction of sleep duration that occurred in the long sleeper group was obtained both for night sleep (489 ± 54 versus 508 ± 42 min, $p = 0.05$) and for daytime sleep (7 ± 13 versus 23 ± 35 min, $p = 0.019$). There was no difference in terms of sleep habits between compliant and noncompliant patients. Their bedtimes were comparable (11:02 P.M. ± 24 min and 11:05 P.M. ± 22 min, respectively) and there was no difference in terms of sleep duration (463 ± 39 min versus 432 ± 73 min, $p = 0.098$) and waking time (7:01 A.M. ± 26 min versus 6:38 A.M. ± 49 min, $p = 0.27$). The start of nCPAP treatment was also comparable for both groups, although different with bedtimes (11:20 P.M. ± 31 min and 11:42 P.M. ± 44 min, respectively). This means that the noncompliant subjects were potentially sleeping without nCPAP for a mean nocturnal time of 266 min.

## DISCUSSION

This is one of the largest studies examining compliance in consecutive new patients recruited in a multicenter trial. Because the two groups with and without the determination of effective compliance were found to be comparable, it is concluded that the presence of the control unit ($MC^+$) in these newly treated patients did not bias the study significantly, although it seems to have increased slightly the level of compliance. Moreover, as the effective compliance was nearly the same as the objective compliance (more than 95%), several results could be inferred from the whole population of more than 100 patients. This is actually the case as regards relatively high daily duration of CPAP use and the low percentage of noncompliant patients, the two major findings of the present study.

When examining clinical research protocols aimed at evaluating compliance with treatment, one may wonder whether the fact of being enrolled in a clinical trial does not per se alter the results. As the patients know that their compliance is being evaluated and represents one of the end points of the study, this may significantly increase their motivation. The low rate of drop-out (5.78% of patients lost to follow-up) may also be a result of the differences from usual clinical practice. However, these limitations apply to all of the studies examining compliance with nCPAP and already published. Moreover, including a large number of consecutive patients should significantly reduce any bias of selection that may also be present in some studies.

We believe that one of the strengths of our study relies on the fact that the in-hospital support and the home care support were intensive and comparable from one center to another. This indeed forms part of our usual practice. The actual impact of different supporting strategies remains questionable. As regards home care support, simple telephone reinforcement was initially found to be inefficient (13). However, in a more recent report, Chervin and co-workers (14) showed a beneficial outcome of intervention to improve CPAP compliance, written information being probably more effective than frequent phone calls, although the difference did not achieve significance. Another report also demonstrated that intensive support corresponding to three additional CPAP habituation nights and home CPAP education with spouses increased the use at 1 mo from 4.8 to 6.2 h per night (15).

One of the important results from the present study is the close relationship between objective and effective compliance. From the three first studies examining effective compliance, effective compliance appeared to be about 91% of objective compliance (9–11). We found much higher values, ranging from 94 to 98%. This does not rule out the interest in measuring effective compliance, but it strongly suggests that objective compliance measured with a clock-time counter correctly reflects the actual compliance. The only exception would be in subjects exhibiting a low mean value, from which it is impossible to differentiate between intermittent users and regular users using their device for less than 3 or 4 h per night. In the latter case, it might be of interest to identify precisely when the device is used as, for example, sleeping without nCPAP at the end of the night may be deleterious due to the REM sleep period. An alternative way of using effective compliance monitoring would be to use it as an early and sensitive tool in the first days of treatment. Indeed, in reanalyzing their own previously published data (9), Weaver and co-workers reported that both intermittent and low-rate usage of nCPAP appeared during the first 4 d of treatment in half of their 32 subjects (16). A rapid and accurate identification of this pattern of use may be needed to monitor effective compliance during the first week of treatment. This could allow rapid intervention such as home support reinforcement.

Another important result of the present study was the high rate of use of nCPAP and the high percentage of compliant patients. The daily rate of use that we found ranged from 5 to 5.8 h. We acknowledge that the $MC^+$ subgroup of patients tended to be more compliant. This difference cannot be explained by unsuccessful randomization (*see* Table 1). On the other hand, the patients were new to treatment, and were thus unable to identify the compliance unit. Conversely, doctors and technicians were aware of the affiliation of the patients with either the $MC^+$ or $MC^-$ subgroup and this point might have slightly influenced the level of compliance. Considering the worst case scenario, i.e., a CPAP use of 5 h/d, our compliance levels in fact remained higher than in several studies previously reported (9–11). This is particularly true for the study by Kribbs and colleagues (9). In this study, 4.6 h/d has been calculated on the basis of days with ⩾ 20 min of use (i.e., 66.3% of days). The compliance extrapolated for the whole period of treatment including days of non-CPAP use can be estimated as about $4.6 \times 66.3/100 = 3.05$ h/d.

Other groups have reported high compliance rates, particularly in Europe [6 h/d (17), 5.7 h/d (18), 6.5 h/d (19), and 5.7 h/d (20)]. It should be pointed out that these studies deal either with short-term or long-term compliance. However, the values mentioned above seem to be applicable to both. Compliance has been studied in many chronic illness situations. The average compliance with inhaled medication in asthma is 60–70% (21, 22). In hypertensive patients compliance decreases with time to ∼ 60% after a follow-up period of 6 mo (23). In pa-

tients receiving long-term oxygen therapy (LTOT) at home, we have found that only 45% of the patients achieved oxygen therapy for 15 h or more per day (24). These data suggest that 75–80% may be the highest obtainable rate of compliance. Thus, the 79% rate of compliance we have found with CPAP should be considered satisfactory. When examining reviews about compliance with medical treatment in patients with asthma (22), COPD (25), or hypertension (23), no difference in rate of adherence to therapy has been reported when comparing U.S. with European data. Several factors may affect compliance with therapy during sleep apnea: (*1*) motivation linked to severity of symptoms and satisfaction with the mode of therapy; (*2*) perceived discomfort from use of the device; and (*3*) potentially, the degree of education about the disease and medical and technical follow-up of the disease. The major symptomatic benefit obtained with CPAP probably explained the high level of compliance compared with COPD patients under LTOT. The back-up support for apneic patients at home is generally regarded as better in Europe than in the United States (26). This may explain the different rates of adherence to CPAP between the United States and Europe.

At least part of the discrepancies with the first studies on effective compliance may relate to differences in patient education and support. Both Chervin and coworkers (14) and Hoy and colleagues (15), who demonstrated that active information and intervention may increase significantly the duration of use per night (up to 6 or 7 h), support this hypothesis.

Patient education and support may also explain the difference in the percentage of compliant patients. Here again there is a striking difference from some of the results previously published. Kribbs and coworkers (9) found that only 46% of their subjects used their device more than 70% of the nights and more than 4 h/d during days of use. In contrast, using the same criteria, we found between 77 and 82% of patients compliant. When comparing these data with the analysis subsequently published by the same group (16), it appears that their subgroup of noncompliant patients is twice as large. Although we have no information concerning in- and out-hospital support in this last study, we can hypothesize that home support is restricted to the usual home care delivery in the United States. The significant effects of simple interventions such as written information or repeated phone calls (14) favor a major role for early and active home support in reducing the number of low or noncompliant patients.

Both the percentage of compliant patients and the duration of use were established at 1 mo. This is in accordance with what has been reported previously (16), as the mode of compliance seems to be established in the first days of treatment. Moreover, intermittent users seem to decrease progressively their mean nCPAP use (16). This is also what we found, with a trend to reduce the duration of treatment in our noncompliant group from 168 min at 1 mo to 150 min at 3 mo.

When comparing compliant and noncompliant patients, there was no clinical difference and no difference in side effects. None of the anthropometric, functional, and polygraphic variables was significantly different. The mean utilization of the CPAP device in our noncompliant subgroup was 166 $\pm$ 43 min. As in a previous study by Engelman and colleagues (27), we have demonstrated that benefits in terms of daytime sleepiness and snoring can be obtained from an average nightly treatment duration of only 3 h. It is possible that these patients use as much CPAP as is needed to control their main symptoms (i.e., daytime sleepiness and snoring). Interestingly, the increase in daily utilization of the device in the compliant subgroup of patients is associated with a further improvement in other symptoms. Although there was no difference in use depending on the day of the week in the compliant group, there was a reduction of use on Saturday in the noncompliant group. Motivation in this last subgroup may be insufficient to prevent a weekend effect.

Last, we found a relationship between sleep duration and nCPAP therapy. Using data for subjective sleep duration, the subgroup of long sleepers demonstrated after 1 mo of CPAP treatment a reduction in sleep duration that was maintained at 2 and 3 mo. This subgroup, however, still had a longer duration of sleep than did the short sleeper subgroup. This reduction of sleep duration affected both night and daytime sleep. However, daytime sleep was still present in the long sleepers (7 $\pm$ 15 min at 3 mo versus 23 $\pm$ 35 min initially) whereas it was nearly eliminated in the short sleepers (9 $\pm$ 38 min before treatment). This may reflect the improvement in sleep quality under nCPAP. As there was no difference in terms of sleep duration between compliant and noncompliant patients, there is a high probability that a large part of the 266 min representing the difference between the duration of sleep and the duration of treatment represents a period of sleep without nCPAP. Moreover, as the end of the nCPAP session is at 4:02 A.M. $\pm$ 107 min, most of this untreated period may be in the early morning. Although it has been shown that OSAS does not reappear with the same severity when nCPAP is interrupted (28), this is potentially deleterious as REM sleep is more likely to be present at the end of the night. This emphasizes the fact that sleep duration and sleep habits should be monitored when examining compliance with nCPAP therapy.

## Conclusion

In this large European multicenter study, we have shown a high effective compliance with nCPAP and a high proportion of compliant patients. We have also demonstrated that objective compliance as assessed by a built-in time counter is nearly the same as effective compliance, corresponding to the time during which the nCPAP mask is effectively applied. This means that objective compliance measurement is a reliable tool for the vast majority of patients. We have also confirmed that adherence to treatment is established at 1 mo, which favors an active support system in the first days when initiating treatment. We have shown significant changes in sleep duration in the long sleepers treated by nCPAP. Last, noncompliant patients seem to stop their nCPAP for the latter part of the night. We hypothesize that most of our results showing high compliance may be related to active support both in hospital and at home when starting treatment. Further studies are needed to determine whether this high level of compliance is maintained on a long-term basis.

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