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SLEEP APNEA/HIPOPNEA SYNDROME (SAHS): HOME DIAGNOSIS AND TREATMENT

Alonso Álvarez ML, Terán Santos J, Cordero Guevara J¹,
Coma del Corral MJ¹, Ordax Carbajo E.

Sleep Disorders Breathing Unit. ¹Investigation Unit,
Hospital General Yagüe. Burgos. España

mlalonso@hgy.es

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[Comment of the Reviewer Ramon Diaz Alersi MD.](#) Hospital Puerto Real. Cádiz. España

[Comment of the Reviewer Jorge Rey de Castro, MD.](#) Clínica Anglo Americana. Profesor Principal Universidad Peruana Cayetano Heredia. Lima. Perú.

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SUMMARY

Recent studies associate SAHS with higher cardiovascular morbidity-mortality and we know that even today SAHS continues to be under-diagnosed. This under-diagnosis, signifies, on the one hand, a lowering or loss of health, and on the other, an increase in costs, since it has been demonstrated that patients with undiagnosed or untreated SAHS are higher consumers of health service resources and have higher work absenteeism, while these costs are reduced in SAHS patients treated with CPAP. Therefore, we find ourselves faced with the need to diagnose and suitably treat the largest possible number of patients who suffer from SAHS.

The diagnostic method of choice continues to be supervised nocturnal PSG in the sleep laboratory, however, the future of SAHS diagnosis is inevitably moving towards the use of simplified systems with a high sensitivity and specificity. In this sense, the Respiratory Polygraphy represents an alternative tool for the diagnosis of SAHS, being able to be carried out in the home of the patient, just like the Auto-CPAP systems. Thus, the current approach to SAHS has changed and therefore, a patient with a high probability of suffering from SAHS, is able to have a RP carried out at home which might diagnose SAHS and later to have the CPAP adjusted to the optimum pressure level, as a recording using Auto-CPAP, could be carried out at home.

With this new approach to SAHS, waiting lists could be reduced and thus reduce the under-diagnosis. All this brings about an implicit saving of resources. The place of diagnosis will basically be the home, and in this sense, the development of telematic applications will contribute significantly to the modification of diagnostic strategies.

The success of this form of approach to SAHS, will be established with a suitable selection of subsidiary diagnosed patients and adjustment of home treatment, therefore, each sleep unit must set up its own diagnostic-therapeutic strategy which may be more cost effective.

Key words: Respiratory Polygraphy. Sleep Apnea Syndrome. AutoCPAP

RESUMEN:

Estudios recientes, relacionan el SAHS con mayor morbimortalidad cardiovascular y por otro lado, sabemos que aún hoy en día, el SAHS sigue estando infradiagnosticado. Este infradiagnóstico supone, por un lado, un déficit o pérdida de salud y por otro lado, un aumento de costes, ya que está demostrado que los pacientes con SAHS no diagnosticados ni tratados, son mayores consumidores de los servicios de salud y presentan mayor absentismo laboral, mientras que estos costes se reducen en los pacientes con SAHS tratados con CPAP. Por tanto, nos encontramos ante la necesidad de diagnosticar y tratar adecuadamente al mayor número posible de pacientes que padezcan un SAHS.

El método diagnóstico de elección, sigue siendo la PSG nocturna vigilada en el laboratorio de sueño, sin embargo, el futuro del diagnóstico del SAHS pasa indefectiblemente por el empleo de sistemas simplificados con alta sensibilidad y especificidad. En este sentido, la Poligrafía Respiratoria, representa una alternativa útil para el diagnóstico del SAHS, pudiendo ser realizada en el domicilio del paciente, al igual que los sistemas Auto-CPAP. De esta forma, el abordaje actual del SAHS ha cambiado y así, un paciente con alta probabilidad de padecer un SAHS, se le puede realizar una PR domiciliaria que diagnostique el SAHS y posteriormente para ajustar el nivel de presión óptima de CPAP, se le podría hacer un registro domiciliario de Auto-CPAP.

Con este nuevo abordaje del SAHS, se podrán disminuir las listas de espera y por tanto disminuir el infradiagnóstico. Todo ello conlleva implícitamente un ahorro de recursos. El lugar del diagnóstico, será fundamentalmente el domicilio, y en este sentido, el desarrollo de aplicaciones telemáticas contribuirá de forma importante a la modificación de las estrategias diagnósticas.

El éxito de esta forma de abordaje del SAHS, vendrá marcado por una adecuada selección de los pacientes subsidiarios de diagnóstico y ajuste de tratamiento domiciliario, por lo cual, cada unidad de sueño debe establecer su propia estrategia diagnóstico-terapéutica que resulte más costo-efectiva.

Palabras Clave: Poligrafía respiratoria. Síndrome de apnea del sueño. AutoCPAP

1.- INTRODUCTION

Sleep Apnoea/Hypopnoea Syndrome (SAHS) is characterised by symptoms of daytime sleepiness, neuropsychiatric and cardio-respiratory disorders secondary to repeated episodes of upper airway obstructions during sleep, which cause oxygen desaturation and arousals resulting in unrefreshing sleep¹.

The [diagnosis of suspected SAHS](#), should be carried out from clinical history, including the presence of symptoms of excessive daytime sleepiness, unrefreshing sleep, morning headaches, cognitive deterioration, depression, nocturnal micturition etc., as well as nocturnal snoring and nocturnal apnoea episodes, as related by bed companions ²

To diagnose SAHS with certainty, a complete and supervised nocturnal polysomnography (PSG) should be carried out ^{3, 4} in the sleep laboratory. The PSG consists of the continuous recording and supervision of the state of wakefulness and spontaneous sleep, including recording of neurophysiological and cardiorespiratory parameters which will allow the quantity and quality of the sleep to be evaluated, as well as identifying the different respiratory events and their cardiorespiratory and neurophysiological repercussions.

The [number of patients with SAHS](#), diagnosed in daily practice, depends on [the availability of suitable technical resources](#), the number of sleep laboratories and [accessibility to them](#)^{5, 6, 7}. SAHS is under-diagnosed ⁸. [Studies carried out in Spain estimate](#) that around 25% of the general middle-aged adult population have an abnormal Apnoea/hypopnoea index per hour of sleep (AHI) and at least 1.2 million people suffer from a clinically relevant SAHS, treatable with continuous positive airway pressure (CPAP) ^{9,10}.

The increased prevalence of SAHS, as well as the limited resources available has brought about long waiting lists, which inevitably leads to the need to look for more effective and less costly diagnostic techniques, alternative to or complementary to PSG, which might enable SAHS to be suitably diagnosed and treated.

2.- HOME DIAGNOSIS OF SAHS**A.-CURRENT STATE OF THE HOME DIAGNOSIS OF SAHS**

In 1994, the American Sleep Disorders Association (ASDA), established [four diagnostic levels](#) for the evaluation of Sleep Breathing Disorders (Table 1)¹¹, (Figure 1)

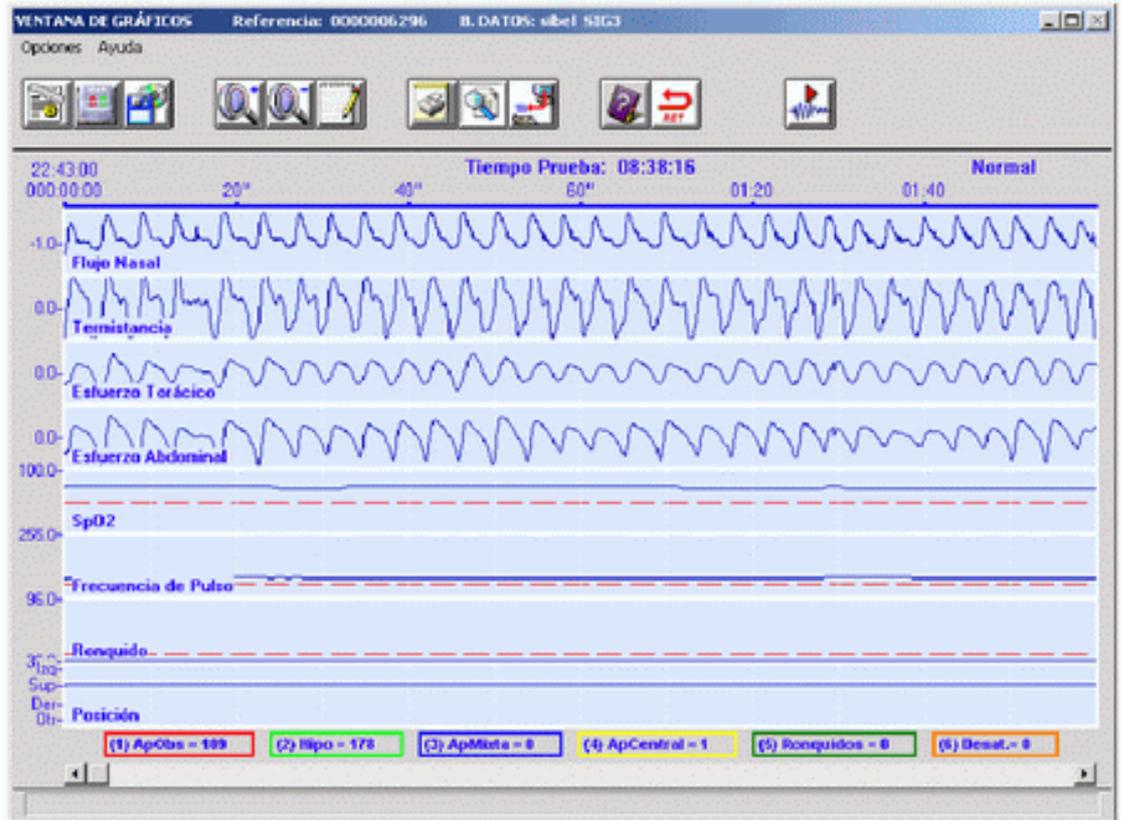


Figure 1a

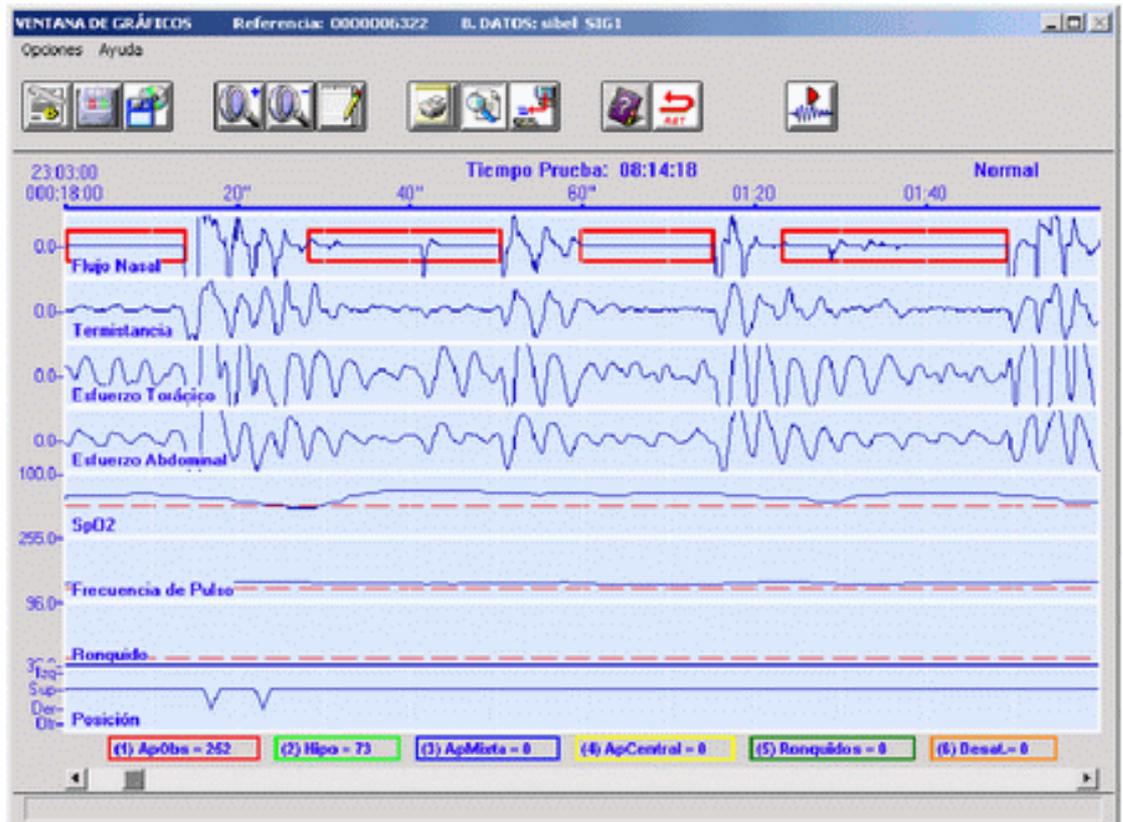


Figure 1b

Figure 1.- Respiratory Polygraphy System, level III, Sibelhome®. From top to bottom, air flow by nasal cannula and by thermistor, thoracic strength, abdominal strength, oxygen saturation, pulse rate, snoring and position. Figure 1, corresponds to 2 minutes of normal recording and in 1b, presence of apnoeas with cessation of flow in the cannula as well as the thermistor.

TABLE 1: DIAGNOSTIC LEVELS OF ASDA

NIVEL	Parameters	Position	Leg movements	Intervention
I: Standard PSG	Minimum: 7 EEG, EOG, EMG, ECG, Resp. Strength Air flow Sat. O ₂	Documented	Desirable Optional	Possible
II: Portable PSG	Minimum: 7	Can be measured	Desirable Optional	NOT POSSIBLE
III: Portable Systems for Sleep Apnoea	Minimum: 4 2 Ventilation ECG, Sat O ₂	Can be measured	Can be Recorded	NOT POSSIBLE
IV: Recording of one or two Bio-parameters	Minimum of one	Not Measured	Not Recorded	NOT POSSIBLE

EEG: Electroencephalogram; EOG: Electro-oculogram; EMG: Electromyogram; ECG: Electrocardiogram; Sat O₂: Oxygen Saturation.

In 1998, the Agency for Health Care Policy and Research in the United States (AHCPR)^{12, 13}, carried out a [meta-analysis of the procedures used for the diagnosis](#) of SAHS, by reviewing the literature from 1980 to 1997. In an evaluation of portable equipment potentially useful for home diagnosis, 25 validated studies were included, the majority of them analysed their results in sleep laboratories and their sensitivities and specificities varied between 33%-100%. This variability of results did not allow conclusions to be drawn.

More recently, a new [systematic review of the literature was carried out](#)¹⁴, in which three scientific societies, the American College of Chest Physicians (ACCP), The American Thoracic Society (ATS), and The American Academy of Sleep Medicine (AASM), tried to establish [guidelines for the use of portable systems](#) for the diagnosis of SAHS¹⁵:

- 1.- Level II, Unsupervised PSG: There is no data available to recommend the its use in daily clinical practice, there being a limited number of published studies.
- 2.-Level III, Portable sleep apnoea systems or Respiratory Polygraphy: There is evidence to accept its use in the sleep laboratory, both to confirm and rule out SAHS.
- 3.- Level IV, Continuous recording of one or two bio-parameters: They are not recommended for routine use in sleep laboratories or in unsupervised situations.

The four levels of diagnostic monitorization are showed in Table 1.

B.- HOME DIAGNOSIS OF SAHS STRATEGY

A series of questions are essential at the time of approaching the diagnosis of SAHS: Which test to use?, What implications will the results of the test have on the risks and clinically important consequences of SAHS?, What to do in the case of a negative result?, What to do in the case of patients diagnosed with SAHS using RP and starting treatment with CPAP, which might have a poor response to treatment?

From the studies carried out to date, what does seem clear and there is agreement as regards the home diagnosis of SAHS, is:

- 1.-The use of Level II and Level IV systems is not recommended
- 2.- Home diagnosis is centred on Level III systems.

B.1.- ADVANTAGES OF RESPIRATORY POLYGRAPHY:

- 1.- The systems are more straightforward than PSG, and therefore, they could increase accessibility to diagnosis.
- 2.- The polygraphs are, in general, cheaper than polysomnographs.
- 3.- They could be used in the home, thus avoiding a strange environment such as hospital and being away from their normal surroundings.

B.2.- LIMITATIONS OF RESPIRATORY POLYGRAPHY

- 1.- Validation studies of RP have largely been carried out in sleep laboratories, and not in the patient's home.
- 2.- Heterogeneity of the systems available: The polygraph systems available use different measuring systems. Therefore, a consensus would be needed as regards the parameters to measure, channels necessary, and measurement methods.
- 3.- These systems do not allow the recording of sleep.
- 4.- With RP, the RDI (the respiratory disturbance index) is calculated depending on the total time of the study and not the total sleep time, as this can underestimate SAHS.
- 5.- If a patient has a clinical picture highly suggestive of SAHS and the RP study is negative or inconclusive, a PSG will have to be carried out.

B.3.- HOME STUDIES:

There are few validation studies of RP carried out in the home (HRP), the majority having a limited number of patients and with level IV systems, as shown in the review carried out by ATS, ACCP and AASM¹⁴. In this respect, our group carried out a validation study of a RP system compared with PSG¹⁶, whose aim was to evaluate the diagnostic usefulness of RP carried out in the home, as well as the costs derived from it. Forty five patients suspected of having SAHS were studied. The correlation between the RDI (respiratory disturbance index in RP) and the AHI (Apnoea/Hypopnoea index in PSG) was $r = 0.727$ and the sensitivity and specificity values for the diagnosis of SAHS are shown in Table 2.

TABLE 2: POINTS SELECTED ON THE ROC CURVE

	Cut-off point	RDI	Effectiveness (%)	Sensitivity (%)	Specificity (%)	VPP (%)	VPN (%)
AHI ≥ 10	Effective FP=FN=1	11.6	82.2	71.4	91.7	88.2	78.6
	Sensitive FP=FN=1	7.2	71.1	90.5	54.2	63.3	86.7
	Specific FP=FN=1	13.70	80	61.9	95.8	92.9	74.2
	Effective FP=2; FN=1	13.70	80	61.9	95.8	92.9	74.2
AHI ≥ 10 + Epworth ≥ 10	Effective FP=FN=1	13.70	79.5	60.0	95.8	92.3	74.2

AHI: Apnoea/Hypopnoea index per hour of sleep on polysomnograph.

RDI: Respiratory disturbance index, events per hour of study in a home respiratory polygraphy.

PPV: Positive Predictive Value; NPV: Negative Predictive Value

FP: False Positive; FN: False Negative

With values of RDI obtained in the ROC curve, the pre-test and post-test probabilities were calculated, the post-test probability of a negative result being (RDI < 7.2), 13.60% and the post-test probability of a positive result (RDI ≥ 13.70) 92.86%. In our area, the performing of a home PR in a patient suspected of having SAHS, assumes a saving of 32.34€ compared with carrying out a PSG, even when a PSG may have to be carried out on doubtful home RP (HRP), repeating non-valid HRP and assuming the additional costs of false positives treated with CPAP. Therefore, RP can currently [be considered as a technique for the diagnosis of SAHS in the home¹⁷](#), taking into account the following set of [considerations¹⁸](#):

- 1.- The use of RP in the home (HRP) should be individualised to the needs of each Sleep Unit¹⁹.
- 2.- Careful selection of patients is required.
- 3.- Doubtful or negative HRP in patients highly suspected of SAHS require the carrying out of a PSG.
- 4.- HRP does not increase costs and using it as a routine protocol, can be cheaper than performing PSG on all patients suspected of having SAHS.
- 5.- RP carried out in the patient's home will improve access to a diagnosis and thus decrease waiting lists.
- 6.- Given that it is a non-supervised technique and does not allow the recording of neurophysiological variables, it is recommended that the patients fill in a sleep diary, in which it should indicate, the approximate hour they went to sleep and woke up, and the subjective perception of the quantity and quality of the sleep.
- 7.- For those centres who might only have RP available, they should establish a suitable level of coordination with units who have PSG available.

Population suitable for home studies:

- 1.- Patients with a low probability of SAHS and without cardiovascular risk factors, in those with a negative HRP as it enables ruling out the existence of SAHS.
 - 2.- Patients with a high probability of SAHS, in those with a positive HRP it enables confirming the existence of SAHS and the establishing of suitable treatment.
- Figure 2 shows an algorithm for the home diagnosis of SAHS.

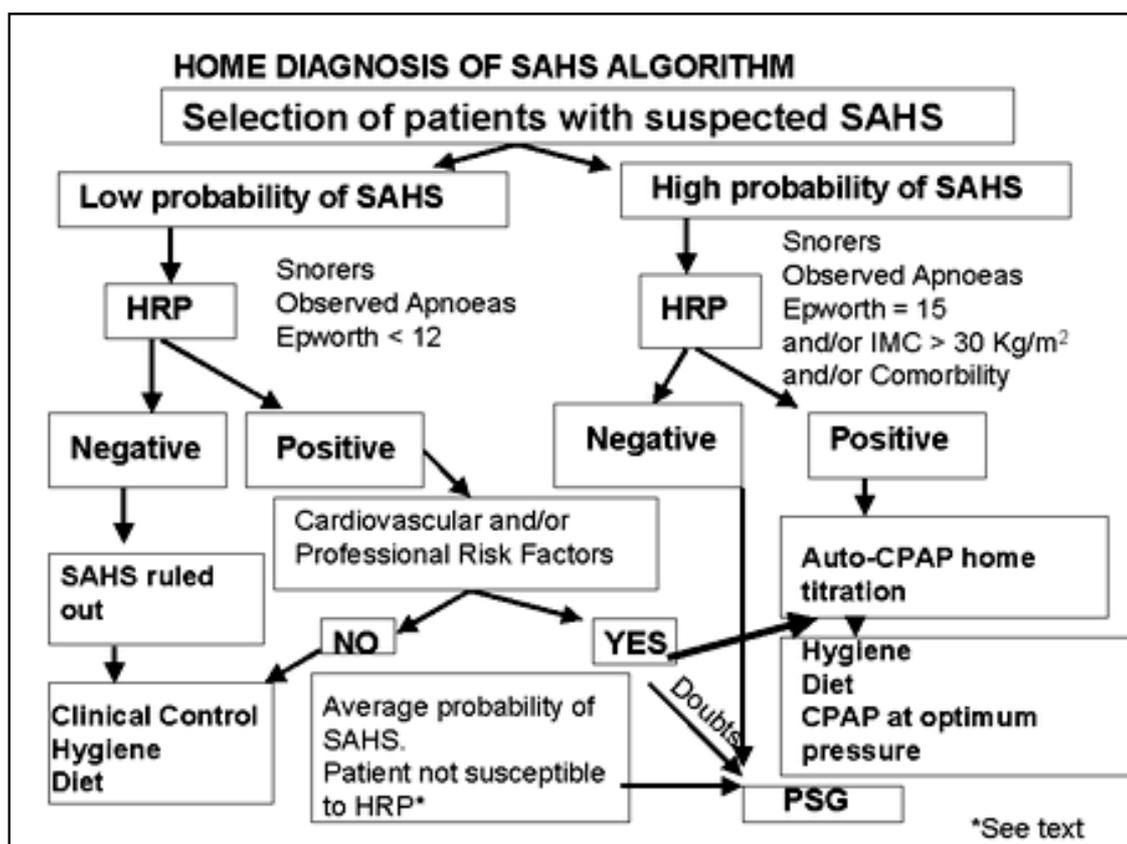


Figure 2: Algorithm for the home diagnosis of SAHS. HRP: Home Respiratory Polygraphy; PSG: Nocturnal Polysomnograph; BMI; Body mass index; CPAP: Continuous Positive Airway Pressure.

Population not suitable for home studies:

- 1.- Patients with symptoms suggestive of other, non-SAHS, sleep disorders.
- 2.- Patients with insomnia.
- 3.- Shift workers.
- 4.- Patients with anxiety-depressive syndromes.
- 5.- Patients with significant comorbidity.

6.- Patients with an intermediate probability of suffering from SAHS, in whom a HRP could be doubtful and a PSG would need to be carried out.

3.- HOME TREATMENT OF SAHS

3.1.- RECOMMENDATIONS FOR THE TREATMENT OF SAHS In 1998 the Spanish Respiratory Disease Society (SEPAR) published some recommendations for the treatment of SAHS [20](#), (Figure 3):

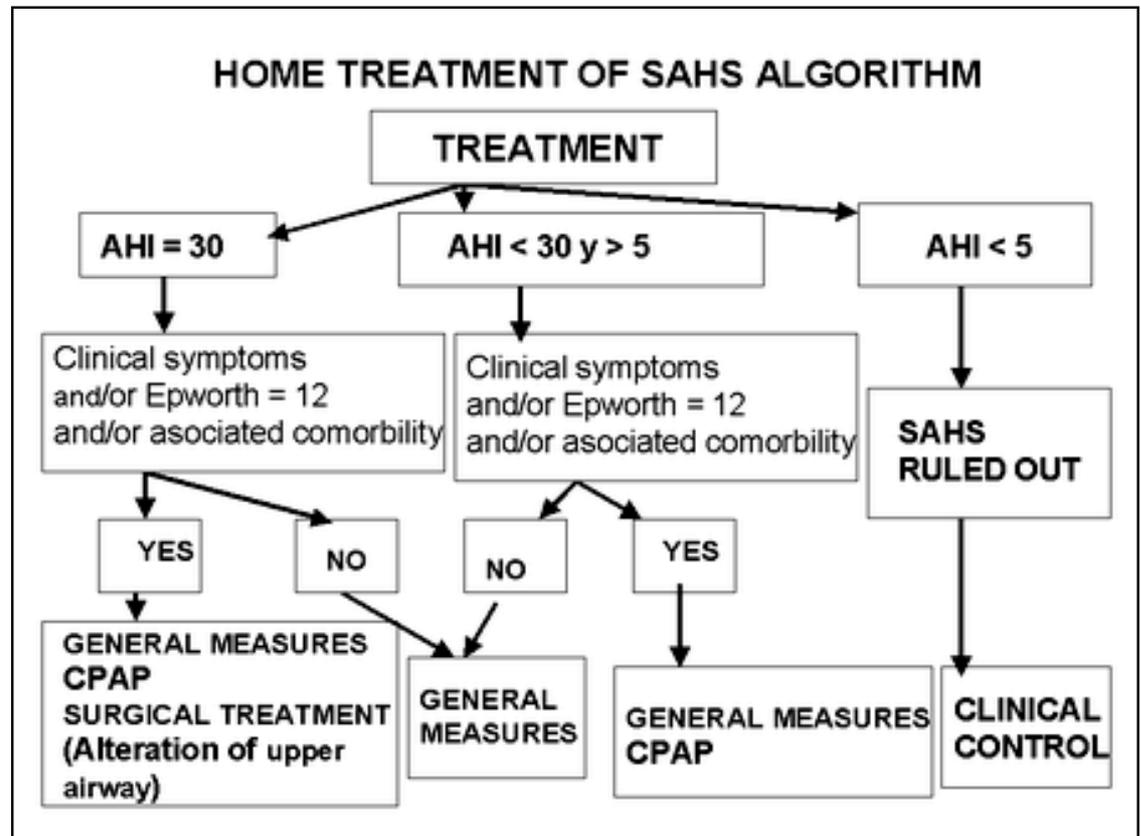


Figure 3: The figure shows an algorithm for the home treatment of SAHS, following the SEPAR guidelines.

3.2.- TYPES OF TREATMENT

The aim of SAHS treatment is the improvement or disappearance of the clinical symptoms and the correction of the physiopathological changes, that is to say, the disappearance of apnoeas and hypopnoeas; effective treatments being those which improve the permeability of the upper airways. There should be a multidisciplinary approach to the treatment of SAHS and this can be divided into the following sections:

1.- GENERAL MEASURES

The aim of treatment with general measures would be the elimination of the predisposing factors which trigger off or worsen the malfunction of the upper airway during sleep²¹: Avoid obesity, alcohol, the decubitus supine position ²² whilst sleeping, drugs which might increase upper airway malfunction, such as benzodiazepines²³ and narcotics, and maintain a reasonably healthy sleep routine.

2.- PHARMACOLOGICAL TREATMENT:

More than 100 drugs for the treatment of SAHS have been studied, with limited results²⁴, therefore up to this moment they do not constitute an effective therapeutic alternative.

3.- MANDIBULAR ADVANCEMENT DEVICES (MAD):

The aim of treatment with intra-oral devices should be the improvement of the snoring of SAHS or otherwise, by means of performing one or more of the following functions ²⁵: Modifying the position of the upper airway structures, widening the upper airway and/or helping to prevent the upper airway from collapsing.

The ASDA consider them as a valid alternative²⁵, first choice in: Simple snoring, patients with mild SAHS, patients with mild-moderate SAHS with a low body mass index and patients with Upper Airway Resistance Syndrome (UARS).

Being an alternative second choice in:

- a.- Patients who do not respond to or refuse CPAP.
- b.- Patients with a high surgical risk.
- c.- Patients with a low response to surgical treatment.

4.- SURGICAL TREATMENT

The surgical techniques currently applied can be summarised as:

4.1.- Content reduction surgery: Nasal surgery, palate-pharyngeal surgery and tongue surgery.

4.2.- Widening of contents surgery: Maxillofacial surgery

They are aggressive surgical techniques and are generally reserved for failures of treatment with CPAP or patients who refuse it from the start.

4.3.- Tracheostomy: Is reserved for emergency situations in patients with severe SAHS and as preventive treatment in patients at risk who are going to be subjected to other surgical treatments, with the aim of decreasing peri-operative risks.

5.- CONTINUOUS POSITIVE AIRWAY PRESSURE (CPAP):

The use of continuous positive pressure on the upper airway, CPAP, is the treatment of choice for SAHS. It was developed by Sullivan in 1981 and consists of a pump which applies a predetermined pressure through a nasal mask fitted with a harness and adapted to the patient's face. The system generates a constant flow and applies a pressure to the upper airway, preventing its static (apnoea) as well as its dynamic (hypopnoea) collapse during sleep. For this reason it is seen as a mechanical action.

CPAP corrects obstructive, mixed, and occasionally central apnoeas, eliminates hypopnoea and suppresses snoring. It prevents oxygen desaturation, secondary electroencephalographic awakenings (arousal) and normalises the architecture of sleep. CPAP brings about a remission of the symptoms of SAHS, decreases or eliminates pathological daytime sleepiness, causes a recovery in the attention capacity and improves the quality of life. Treatment with CPAP also reduces the risk of traffic accidents in patients with SAHS and it appears to lower the blood pressure in a high percentage of hypertensive patients with SAHS, and it is even attributed to playing [a certain role in the treatment of cardiac failure¹⁷](#).

CPAP is not a curative treatment, which implies that its application has to be continuous.

5.A.- Secondary effects of CPAP:

The appearance of secondary effects is common during the first weeks of CPAP use. They are generally mild, transient and with a good response to local measures. The most frequent are: nasal congestion and/or obstruction, skin irritation, pharyngeal dryness, noise, conjunctivitis, headaches, epistaxis, cold, insomnia, aerophagia, claustrophobia.

5.B.- Adjustment to the optimum CPAP pressure or CPAP titration: Each patient requires a determined CPAP pressure which must be adjusted to the needs of the individual. There are several ways of adjusting the level of CPAP for each patient:

1.- Adjustment of CPAP level by means of conventional PSG in the laboratory: Two studies need to be carried out, one diagnostic and the other for the CPAP pressure titration.

2.- Adjustment of CPAP level by means of the Split-Night procedure. In the Split-Night method, the diagnosis has to be made in the first part of the night and the adjustment of the CPAP pressure in the second part, [thus there is a saving of one sleep study 26](#).

3.- Adjustment to optimum CPAP pressure by means of Auto-CPAP systems: There are several auto-CPAP systems, the most accepted being those which modify the pressure depending on the inspiratory flow wave. They provide an individualised pressure, which is adapted to the needs of the patient, with the aim of suppressing respiratory events. They contain a pneumotachograph and a pressure transducer which enables the pressure, flow, volumes and system leaks to be recorded. Other auto-CPAP systems respond to the presence of snoring using algorithms based on its frequency.

The most significant characteristic of auto-CPAPs, is that these systems [can be used for the adjustment of the CPAP](#) pressure to optimum level in the patient's home. Masa et al²⁷ carried out a multicentre, randomised parallel group study in 360 patients with SAHS, candidates for treatment with CPAP, with a mean AHI of 60. In this study the results on the adjustment to the optimum CPAP pressure using PSG, an automatic auto-CPAP system or with a mathematical formula were not statistically significant.

4.- Adjustment to optimum CPAP pressure by means of Respiratory Polygraphy: The American Academy of Sleep Medicine does not advise this option and with the introduction of auto-CPAP has practically ruled it out for adjusting the CPAP level.

6.- TREATMENT OF SAHS WITH AUTO-CPAP

Taking into account that conventional CPAP systems supply a fixed pressure all night and every night, these systems attempt to adapt to the needs of each night. However, in a recently published meta-analysis,²⁸) whose aim was to compare the effectiveness of auto-CPAP with CPAP, it only showed a reduction in mean pressure of 2.2 cm of H₂O. The compliance to treatment, the improvement in daytime sleepiness and the elimination of respiratory events were similar in fixed CPAP and auto-CPAP, therefore, it cannot be considered that continuous treatment of a patient with SAHS should be carried out with auto-CPAP, except in a particular subgroup who do not tolerate CPAP at a fixed pressure.

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Todas las direcciones electrónicas, han sido vistas el 29 de diciembre de 2005

Comment of the Reviewer Ramon Diaz Alersi MD. Hospital Puerto Real. Cádiz. España

OSAHS is a public health problem. Its prevalence in Spain is estimated to be from 4-6% in men and from 1-2% in women. It has the highest morbidity-mortality among all sleep disorders. Its most noticeable characteristic is extreme daytime sleepiness, but it also gives rise to cognitive changes and memory loss, social problems and mood changes, which together can cause social and work problems for the person affected. Also excessive sleepiness frequently causes problems with driving, leading to these patients being involved in road traffic accidents three times more often than the normal population.

SAHS is also becoming increasingly related to other diseases, particularly cardiovascular. SAHS is often associated with hypertension, (although also with obesity, therefore it is not easy to establish a cause-effect relationship), an increased risk of stroke, ischaemic heart disease, right heart failure and pulmonary hypertension. It can also cause a deterioration in left heart failure. Lately, it has also been associated with type 2 diabetes and insulin resistance. OSAHS has also been related with poor medication control of high blood pressure.

For these reasons, improved diagnosis and treatment of this syndrome is required, as it is still currently under-diagnosed and under-treated. This article reviews the different diagnostic methods, paying special attention to the most straightforward technologies, which are those which can be applied to the greatest number of patients. Treatment is also reviewed, in constant change in the last few years, particularly in surgery and ventilator support. The former is becoming more accessible owing to minimally invasive techniques and outpatient surgery. The latter is benefiting from a constant feedback of equipment designed for non-invasive mechanical ventilation, destined for other respiratory diseases, and which are increasingly more sophisticated and personalised.

Comment of the Reviewer Jorge Rey de Castro, MD. Clínica Anglo Americana. Profesor Principal Universidad Peruana Cayetano Heredia. Lima. Perú.

.- The practical needs, the advances in technology and control of costs in the diagnosis of Sleep Apnoea/Hypopnoea Syndrome (SAHS) in recent years has inevitably led to simplifying orthodox procedures with the aim of achieving higher output without sacrificing work quality. In this sense, the concept of simplifying a test considered as the gold standard in sleep medicine has been crucial in the last few years. However, conventional polysomnography has gained this honoured position despite being a complex and expensive test.

As regards this subject, and from our point of view, there are two well defined clinical schools of thought. On the one hand the inflexible Anglo-Saxon position expressly represented by the American Academy of Sleep Medicine, cited in the literature references 11 to 15 by Alonso Alvarez et al in the article which is been commented on here. In this case polysomnography represents the procedure of choice in clinical practice for establishing a suitable diagnosis, clearly underestimating the Level III, also called screening, tests. On the other hand, the Spanish school, specifically represented by pneumonologists and the Spanish Society of Pneumology and Thoracic Surgery (SEPAR), who are interested in the validation of simplified diagnostic equipment and their implementation following algorithms as proposed in the article by the group of investigators from the Yagüe General Hospital in Burgos. These schools of thought have been developed under totally different contexts. We specifically look at health budgets and safety cover with substantially different realities. This makes the difference.

In the case of the less developed countries- where I work- where the budgetary restrictions are even greater than the choice of an economic technology, it is crucial. In that sense, there is little point in trying to follow a diagnostic sequence with burdensome technology if the economic means are not available to implement it, when, on the other hand, it is possible to establish with thoroughness, the nature of the disease in a patient using cheaper instruments and procedures.

The publication by the Burgos group has that merit. An algorithm is set out which sequentially establishes or rejects the diagnosis using respiratory polygraph equipment set up in the home. There is no doubt that the group in question have experience in the subject, they suitably select the patient according to the clinical aspects and finally they have quantified, through validation comparing polysomnography, the performance of the equipment used on patients with a high and low possibility of having SAHS.

To use simplified equipment for the diagnosis of SAHS, each sleep centre, ideally, should make their own measurements with their target population, this improves the system and protects the patient from diagnostic errors. The publication by Alonso Alvarez et al, in that sense is an important contribution in the area of sleep breathing disorders. _

* Correspondence:

Dra. María Luz Alonso Álvarez
Unidad de Trastornos Respiratorios del Sueño
Hospital General Yagüe
Avda. del Cid 96
09005 Burgos. España

Email: mlalonso@hgy.es

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