Sleep Medicine Reviews 18 (2014) 341–347

Contents lists available at ScienceDirect

Sleep Medicine Reviews

journal homepage: www.elsevier.com/locate/smrv

CLINICAL REVIEW

Unattended home-based polysomnography for sleep disordered breathing: Current concepts and perspectives

Marie Bruyneel*, Vincent Ninane

Chest Service, Saint-Pierre University Hospital, Rue Haute, 322, 1000 Brussels, Belgium

ARTICLE INFO

Article history:
Received 27 June 2013
Received in revised form
3 December 2013
Accepted 3 December 2013
Available online 12 December 2013

Keywords:
Home unattended polysomnography
Obstructive sleep apnea
Sleep quality
Sleep disorders
Telemedicine

SUMMARY

Recently, portable sleep recording devices became an accepted alternative to polysomnography (PSG) for obstructive sleep apnea (OSA) diagnosis in patients with a high pre-test probability of moderate to severe OSA but home polysomnography (H-PSG) was not recommended because there were insufficient data.

The present review has analysed six prospective randomized crossover studies comparing H-PSG to in-lab PSG.

These studies convincingly showed that H-PSG allows complete sleep evaluation. The quality of patients' sleep tends to be better at home. H-PSG is accurate for OSA diagnosis and the failure rate is low despite the absence of supervision. In addition, it could offer a final and comprehensive diagnosis for many other sleep disorders.

It is also likely that H-PSG can reduce PSG-related costs but complete cost-effectiveness analyses are not yet available.

Recently, remotely attended H-PSG via telemonitoring has been tested and may reduce H-PSG failure rate.

In conclusion, H-PSG can be used to rule-in and rule out OSA in suspected patients, even in the presence of co-morbidities and is an alternative when simplified sleep testing is negative.

Future developments should target simplification of technical aspects of H-PSG, together with remote monitoring, in order to obtain good quality H-PSG performed in adequate conditions.

Introduction

Obstructive sleep apnea syndrome (OSA) is a major condition that is now recognized as an independent risk factor for hypertension and cardiovascular disease. It is characterized by repeated episodes of apnea and hypopnea during sleep usually leading to significant hypoxaemia, subsequent arousals with sleep fragmentation and reduced rapid eye movement (REM) and slow wave sleep. Guilleminault and colleagues were the first to describe this syndrome in 1976 [1]. Since then, awareness of this complex disease, and its consequences, has grown considerably. Prevalence is currently about 6–7% but this is probably an underestimate and numbers are likely to grow in the future as OSA is closely related to obesity [2,3]. The syndrome is associated with a significant morbidity and mortality. Indeed, excessive daytime sleepiness is responsible not only for impaired quality of life and neurocognitive performance [4], but also for road traffic accidents [5]. It addition, it has been proven that OSA is an independent risk factor for the development of cardiovascular disease, including hypertension, coronary artery disease, congestive cardiac failure, and stroke [6]. Diabetes and metabolic syndrome are also associated metabolic conditions [7,8].

As a consequence, OSA is now considered as a chronic disease leading to increased mortality and is associated with major co-morbidities that can be reversed by treatment. Early diagnosis and therapy are likely to be associated with better outcomes. The efficiency of treatment [9] together with costs related to the untreated disease [10] are additional arguments in favour of early diagnosis and rapid access to sleep medicine centres [11]. OSA diagnosis is classically based on attended in-lab polysomnography (PSG), which remains the reference method. Despite the necessity for qualified technical and medical personal, the number of sleep units has increased exponentially, as reflected by the increase in American Academy of Sleep Medicine (AASM) accredited sleep units in USA which rose from 337 in 1996 to 2461 in June 2012. The demand for sleep studies is also increasing and consequently waiting lists often remain long [12,13].

* Corresponding author. Tel.: +32 2 5354219; fax: +32 2 5354174.
E-mail address: Marie_Bruyneel@stpierre-bru.be (M. Bruyneel).

1087-0792/$ – see front matter © 2013 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.smrv.2013.12.002

Abbreviations

AASM	American Academy of Sleep Medicine
AHI	apnea–hypopnea index
CPAP	continuous positive airway pressure
EEG	electroencephalogram
EMG	electromyogram
EOG	electrooculogram
EU	European Union
H-PSG	home polysomnography
MSLT	multiple sleep latency test
MWT	maintenance of wakefulness test
OSA	obstructive sleep apnea
PSG	polysomnography
RDI	respiratory disturbance index
REM	rapid eye movement
SDB	sleep disordered breathing
SE	sleep efficiency
SWS	slow wave sleep
TM-PSG	telemonitored polysomnography
TST	total sleep time

To overcome this problem, many simplified sleep recording devices have been developed and are now widely used to shorten the delay in sleep disordered breathing (SDB) diagnosis and to decrease the related costs [14]. Recently, the AASM issued new recommendations concerning type 3 and 4 recording devices (type 3 corresponds to limited channel devices, usually 4–7 channels whereas type 4 only includes one or two channels with oximetry as one of them [15]): "*Portable monitoring may be used as an alternative to PSG for the diagnosis of OSA in patients with a high pre-test probability of moderate to severe OSA. Portable monitoring may be indicated for the diagnosis of OSA patients in whom in-laboratory PSG is not possible (…) and to monitor the response to non-CPAP treatments for sleep apnea*." [14].

The use of these simplified devices offers numerous advantages including increased healthcare accessibility [16], earlier treatment initiation [17], better patient comfort and potential cost-savings [17,18]. Although the waiting time to obtain a sleep test has been reduced there are, however, little current data to support this [19,20].

Type 3 recordings are frequently associated with sensor losses and lead to technically inadequate recordings in 5–30% of the cases that bring about test repetition [17,21]. Other concerns are related to limitations in sleep time evaluation. With type 3, sleep time cannot be precisely assessed and arousals are impossible to score. This problem leads to underestimation of SDB severity [18,22,23]. Another concern is related to the correct distinction between OSA, central sleep apneas and periodic breathing although one study, in stable heart failure patients, showed good accuracy for OSA diagnosis and the ability of the device to assess central and obstructive events correctly [24].

Many studies have compared type 3 monitors with PSG but since they use various sensors and recorders, generalization of the results are difficult to pool for systematic review [22]. Type 3 tools are so heterogeneous that a review of their classification was performed recently to take into account the specificities of the monitors [25].

Despite these limitations these studies have confirmed the overall usefulness of type 3 devices, especially if we focus on the outcome which results in earlier access to treatment for the patient [26].

Although type 3 recording devices have limitations, they are mainly used to rule-in SDB in high-risk patients [27]. Given their low negative predictive value, all negative records require a confirmation PSG [23,27,28].

An alternative to type 3 recordings is the home polysomnography (H-PSG). It offers both the implementation of home centred care for patients and a complete sleep evaluation allowing the possibility of diagnosing a large panel of sleep disorders.

Use of type 2 devices (full unattended PSG [15] or H-PSG) has been a subject of debate for years. It is expensive, complex and time-consuming, but has the advantage of being a complete sleep study (electroencephalogram (EEG), movements, cardiocirculatory), allowing not only OSA diagnosis but also diagnosis of numerous other sleep disorders [29–31]. It is a discovery tool rather than a verification tool which is the case for most of the type 3 devices [27]. To date, the AASM still considers that there remain insufficient data to recommend routine use of H-PSG [29].

These devices are intended to perform as well as attended PSG but in an unattended surrounding, without continuous supervision. A trained sleep technician must perform the hook-up of the device, and this factor limits the wider use of this technique.

In this review, we aimed to assess the role of H-PSG through reviewing current available literature.

Methods

Search strategy and selection criteria

We conducted a bibliographic search of the medical literature in June 2013. Medline and Cochrane Library Plus databases were searched in order to extract randomized trials comparing H-PSG and in-laboratory attended PSG. A common search strategy was applied, using the following search terms: "home polysomnography" or "unattended polysomnography" or "randomized AND home AND polysomnography" or "randomized AND unattended AND polysomnography" to extract accurate English published original papers.

Data extraction

Data extracted from these studies included number of patients, inclusion criteria (symptoms, questionnaires), technical aspects related to PSG (hook-up location, PSG quality, failure rate), OSA severity and accuracy of H-PSG for OSA diagnosis (sensitivity, specificity, positive and negative predictive values, likelihood ratio), sleep parameters, subjective assessment of PSG and cost data.

Results

At the present time, six prospective randomized crossover trials comparing home unattended PSG (H-PSG) and in-lab attended PSG, totalling 369 patients, have been published [32–37]. Detailed results of these studies are given in Tables 1and 2.

Four studies [34–37] aimed to compare H-PSG and in-lab attended PSG for OSA diagnosis. In three of the studies included [34,36,37], the majority of the patients were middle-aged obese males, clinically suspected of suffering from OSA, and complaining of excessive daytime sleepiness. In the study conducted by Iber et al. [35], a cohort without pre-existing sleep-clinic evaluation was screened for sleep complaints by a sleep questionnaire, in order to identify a specific pool (50% women, 67% snorers, 50% subjects 40–60 y and 50% subjects >60 y), such that the target population was different and included less severe SDB than in the other studies.

A fifth study [32] included patients requiring a polysomnography, regardless of suspected diagnosis.

The last study was designed to compare sleep quality at home and in the sleep lab before multiple sleep latency test (MSLT) and