The Journal of Laryngology & Otology (2009), ***123***, *746–749*.

doi:10.1017/S0022215109004794

Main Article

Use of a screening tool for detection of sleep-disordered breathing

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Abstract

Background: Sleep apnoea, whether obstructive or central, is usually diagnosed by polysomnography. A simpler tool for screening high risk populations may be of value.

Methods: We compared a portable device using nasal pressure cannulae and a high-sensitivity pressure sensor (the ApneaLink®) with our standard polysomnography technique for diagnosing sleep apnoea (using the Embletta® device), in 67 patients being investigated for possible sleep apnoea. The patients' average age was 52.6, 79 per cent were male, the mean body mass index was 32.3, and the mean Epworth sleepiness score was 13.0.

Results: Twenty-five patients (45 per cent) were identified as having an apnoea–hypopnoea index of >15, as measured by the Embletta. The mean (standard deviation) apnoea–hypopnoea index was 21.5 ± 23.0 as measured by the Embletta and 24.3 ± 26.2 as measured by the ApneaLink. The sensitivity of the ApneaLink for an apnoea–hypopnoea index cut-off point of 15 was 92 per cent and the specificity was 96.7 per cent. The negative predictive value of the ApneaLink for an apnoea–hypopnoea index of ≤ 15 was 94 per cent.

Conclusions: The ApneaLink is a useful tool for screening patients thought to have possible sleep apnoea, and for selecting patients for definitive diagnostic testing.

Key words: Sleep Apnoea Syndromes; Polysomnography

Introduction

Up to 25 per cent of the general population may have a mild degree of obstructive sleep apnoea (OSA),[1–4] with perhaps 2 per cent having more severe OSA warranting treatment. Sleep apnoea is more common with age.[5] Obstructive sleep apnoea is associated with obesity and ageing, and is caused by intermittent upper airway collapse during sleep. In contrast, central sleep apnoea is a feature of chronic heart failure. Estimates of the prevalence of sleep apnoea depend upon the population studied, but in a non-selected population of 700 patients with chronic heart failure, a third had OSA and 40 per cent had central sleep apnoea with an apnoea–hypopnoea index (AHI) of 15 or more.[6]

The 'gold standard' diagnostic investigation for sleep-disordered breathing is polysomnography. However, this technique is expensive and time-consuming, and requires multichannel recordings. Testing may require overnight hospitalisation, but is increasingly performed as an out-patient investigation. A screening tool that accurately detected patients with significant sleep-disordered breathing would be helpful in directing diagnostic services towards appropriate patients. For example, such a tool might prove appropriate for screening high risk populations (e.g. snorers and diabetics), and might be useful in non-specialist units uncertain whom to refer for formal sleep investigation.

We evaluated the effectiveness of the ApneaLink® (ResMed, Sydney, New South Wales, Australia), a portable device using nasal pressure cannulae and a high-sensitivity pressure sensor, in detecting sleep apnoea at home. This device was compared with our standard polysomnography technique for diagnosing sleep apnoea, using the Embletta® device (ResMed), a multichannel recorder receiving data from pulse oximetry, flow detection, and abdominal and chest wall effort sensors.

Methods

The study was approved by the Hull and East Riding ethics committee, with patients giving signed consent. Consecutive patients referred to the sleep service were recruited, with no specific inclusion or exclusion criteria. All patients had been referred by

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Accepted for publication: 10 November 2008. First published online 18 February 2009.

clinicians who suspected them of having sleep-disordered breathing.

A single overnight recording was made using the ApneaLink and the Embletta simultaneously. Patients were shown how to use the two devices. A single set of nasal cannulae was used, with a Y-connector used to send the flow signal to both devices. The Embletta was connected to abdominal and chest wall effort sensors as well as a pulse oximeter. The Embletta effort sensors were conductive loops stretched around the patient's body, giving precise measurements of changes in abdominal and chest circumference. The pulse oximetry probe was fixed around the finger at the level of the nail base. The pressure sensor part of the ApneaLink device received the flow signal via the Y-connector; the same flow signal was sent simultaneously to the Embletta.

Both devices were activated by the patient on retiring to bed.

The patient attended the hospital the next day and the information from the devices was downloaded and read automatically, using the computer software provided with each device. Where an episode of sleep apnoea was reported, this was inspected by one of the authors and confirmed. The AHI was taken as the primary end-point of the recording. An apopnoea episode was defined as cessation of nasal and oral airflow for at least 10 seconds. A hypopnoea episode was defined as an episode of shallow breathing (i.e. airflow reduced by at least 50 per cent) lasting 10 seconds or longer, usually associated with a fall in blood oxygen saturation.

The total number of apnoeic and hypopnoeic episodes was divided by the number of hours of sleep to produce the AHI.

A sleep apnoea episode was detected when a 10-second interval of the signal dropped below 20 per cent of the reference amplitude; the latter was calculated as the mean value of the peak amplitudes found in the 600-second period preceding the event. All events lasting longer than 120 seconds were excluded.

A hypopnoea episode was detected when a 10-second interval of the signal dropped below 70 per cent of the reference amplitude, which was calculated as above. All events lasing longer than 120 seconds were excluded. For a hypopnoeic episode to be scored, a desaturation event had to occur no later than 20 seconds after the start of the episode.

Statistical methods

The Embletta was assumed to be the 'gold standard' against which the ApneaLink was to be tested. Comparisons of the AHIs measured by the two devices were made with paired *t*-tests. The results were compared using Bland–Altman analysis, with receiver-operator characteristics curves constructed to describe the effectiveness of the ApneaLink compared with the Embletta. We assumed that, in order to be effective, the ApneaLink had to be reliable in detecting all patients with an AHI of at least 15 per hour, notionally the level at which treatment with continuous positive airway pressure (CPAP) might be considered if accompanied by symptoms of sleep fragmentation.

Results

Sixty-seven patients took part in the study. No patient declined to take part. Patient characteristics are shown in Table I. In 12 subjects, no satisfactory reading was obtained by the ApneaLink (although good traces were seen on the simultaneous Embletta recordings). In this failed cohort, the average age was 59.3 years, body mass index 36.3 and average AHI (recorded by the Embletta) 25.4, with seven patients having an AHI greater than 15. These failed recordings were due either to failure to activate the ApneaLink ($n = 8$) or to disconnection of the nasal cannulae from the device ($n = 4$), and all occurred within the first 25 patients. These patients' results were excluded from further analysis.

Twenty-five patients (45 per cent of the 55 patients whose data were analysed) were identified by the Embletta as having an AHI of greater than 15. These subjects were slightly older (54.2 ± 9.5 versus 48.6 ± 11.1 years, respectively; $p = 0.05$) and had a higher body mass index (38.3 ± 7.3 versus 32.7 ± 5.7, respectively; $p = 0.004$), compared with the 30 patients who didn't have an AHI of greater than 15. There was no difference in sex distribution or Epworth sleepiness scores. All the apnoeic episodes detected by the Embletta were obstructive.

The mean AHI detected by the Embletta was 21.5 ± 23.0 (median 11.5, range 0 to 87), while that for the ApneaLink was 24.3 ± 26.2 (median 11; range 0 to 86.1) ($p = 0.05$ for comparison of the two). The correlation between these two AHI results is shown in Figure 1, and the Bland–Altman plot for the two AHI results is shown in Figure 2.

The receiver-operator characteristics curve for the performance of the ApneaLink versus the Embletta is shown in Figure 3. The sensitivity of the ApneaLink for an AHI cut-off point of 15 was 92 per cent and the specificity was 96.7 per cent.

TABLE I

PATIENT CHARACTERISTICS

Characteristic	All pts*	Studied pts†
Age (yrs)		
– Mean ± SD	52.6 ± 10.8	51.1 ± 10.7
– Range	34–82	34–78
Sex (%)		
– Male	79	76
– Female	21	24
Body mass index‡ (mean ± SD)	32.3 ± 7.3	35.0 ± 6.9
Epworth sleepiness score (mean ± SD)	13.0 ± 5.2	13.3 ± 5.2
Hypnotics (%)	30	30
BP (mean ± SD; mmHg)		
– Systolic	140.9 ± 18.9	142.5 ± 18.3
– Diastolic	86.0 ± 12.0	87.6 ± 11.3
O_2 saturation (mean ± SD; %)	95.8 ± 2.0	95.8 ± 2.0

No statistically significant differences were found between the studied and the excluded patients. *$n = 67$. †Those for whom both ApneaLink and Embletta recordings were available; $n = 55$. ‡Calculated as kg/m^2. Pts = patients; yrs = years; SD = standard deviation; BP = blood pressure. Hypnotics = proportion of patients regularly taking hypnotic medication at night.

https://doi.org/10.1017/S0022215109004794 Published online by Cambridge University Press

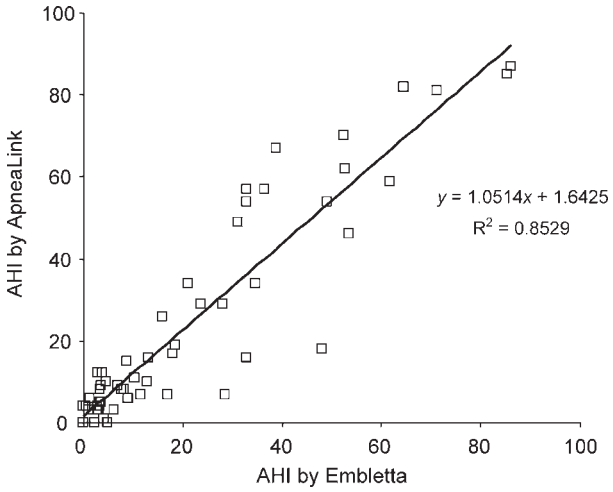

FIG. 1

Correlation between apnoea–hypopnoea indices (AHIs) measured by the Embletta and by the ApneaLink.

Figure 4 shows patients' individual ApneaLink AHI scores, divided by whether their Embletta AHI was greater than or equal to 15 or less than 15. There were thus two false negative studies; however, the ApneaLink's negative predictive value for an AHI of less than 15 was 94 per cent.

Discussion

The aim of the present study was to assess the value of the ApneaLink device as a screening tool to assess patients with suspected sleep-disordered breathing, given its small size and ease of use. The individuals studied were selected on the basis of being consecutive patients attending a sleep clinic, having been referred by their physicians to assess possible sleep-disordered breathing, and thus represented as closely as possible a realistic medical population. We found that the ApneaLink appeared to be an accurate screening tool for this purpose.

Obstructive sleep apnoea is common[1–4] and potentially dangerous.[7–9] Treatment has been

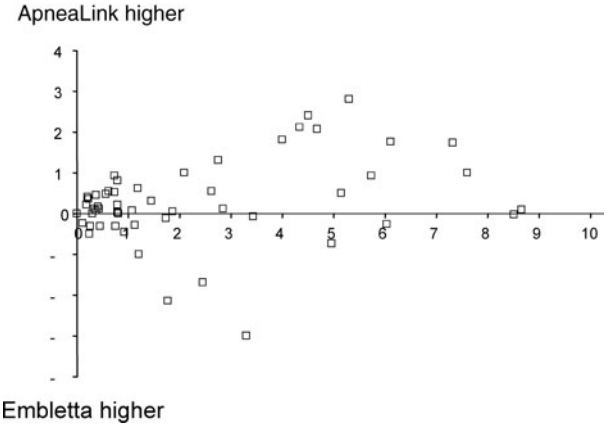

FIG. 2

Bland–Altman plot for apnoea–hypopnoea indices measured by the Embletta and by the ApneaLink.

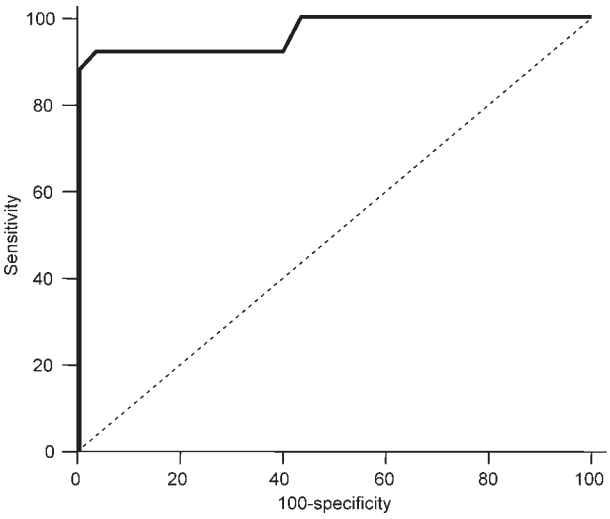

FIG. 3

Receiver-operator characteristics curve for the ApneaLink's ability to detect sleep apnoea. An Embletta-measured AHI of ⩾15 or <15 was assumed to diagnose sleep apnoea.

available since the 1980s in the form of nocturnal CPAP, proven effective in the 1990s.[10,11] The National Institute for Clinical Excellence is currently appraising '... the clinical and cost effectiveness of continuous positive airways pressure... for the treatment of obstructive sleep apnoea/hypopnoea syndrome'. Selecting which patients should receive CPAP is obviously a challenge when formal sleep study (the definitive diagnostic test) is not widely available and is expensive and labour-intensive to administer. In these circumstances, a simpler screening tool would have clear advantages.

The ApneaLink device is cheaper and has a much shorter preparation time than formal sleep study equipment. It is potentially possible for the device to be sent to a patient through the post, and certainly

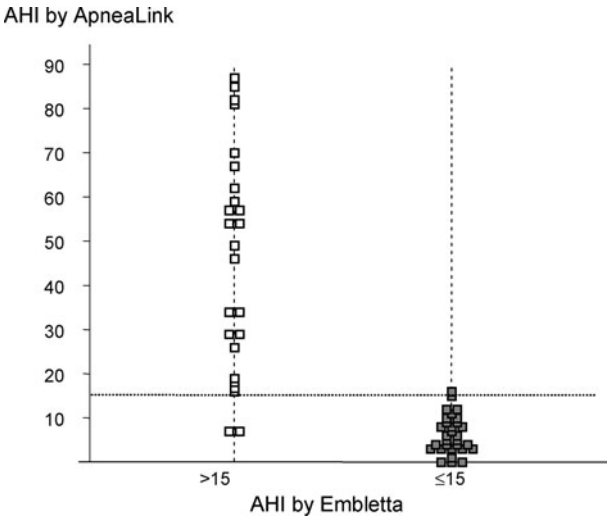

FIG. 4

Patient's individual ApneaLink apnoea–hypopnoea index (AHI) scores, divided by whether their Embletta AHI was ⩾15 or <15. Two false negatives are seen.

https://doi.org/10.1017/S0022215109004794 Published online by Cambridge University Press

possible for the patient to return the device without needing to come to hospital in person.

- **Sleep apnoea, whether obstructive or central, is usually diagnosed by polysomnography**
- **A simple tool for screening high risk populations may be of value**
- **This study compared the ApneaLink®, a portable device using nasal pressure cannulae and a high-sensitivity pressure sensor, with a standard polysomnography technique for diagnosing sleep apnoea, using the Embletta® device**
- **The ApneaLink was cheaper and had a much shorter preparation time, compared with formal sleep study equipment**
- **The ApneaLink cannot replace formal sleep study, but a positive result should lead to formal sleep investigation**

We do not believe that the ApneaLink could replace formal sleep study, but a positive result should prompt such a study. We believe that the ApneaLink gives more useful information than overnight oximetry alone. The negative predictive value of overnight oximetry alone was as low as 38 per cent in some studies,[12] but results depend upon the cut-off used to define the presence of sleep apnoea. A more important problem with using overnight oximetry alone is the very wide variation in physician interpretation of the data.[13] We found that the ApneaLink had a negative predictive value of 94 per cent for AHI scores of 15 or less, suggesting that it would be appropriate as a screening tool. Such a tool could be used for screening high risk populations such as type two diabetics, patients with a body mass index greater than 40 who snore, and patients undergoing assessment for bariatric surgery. In addition, such a screening tool might be useful in ENT and cardiology clinics to identify patients requiring referral for more detailed studies.

Limitations

There was a definite learning process involved in using the ApneaLink. The two patients with false negative results were assessed early in the study. We assumed that the Embletta was a reasonable gold standard for detecting sleep apnoea. We did not study a population in which there might be a high prevalence of central sleep apnoea, such as patients with chronic heart failure. The ApneaLink needs to be tested in other populations to be certain it can reliably detect central sleep apnoea.

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Dr A L Clark takes responsibility for the integrity of the content of the paper.
Competing interests: None declared