Assessment of Sleep and Mood Symptoms in Patients with Undetected Obstructive Sleep Apnea and Atrial Fibrillation

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Abstract

Introduction: Obstructive sleep apnea (OSA) is associated with serious cardiovascular consequences. We aimed to determine:

- The percentage of patients in arrhythmia clinics who show symptoms suggestive of insomnia, non-refreshing sleep, excessive daytime sleepiness, fatigue, decreased alertness, and/or depression;
- If these symptoms predict the severity or the presence of OSA in these patients.

Methods: Non-selected consecutive patients were recruited from outpatient arrhythmia clinics. Patients with previously diagnosed and/or treated OSA were excluded. Validated screening tools were administered. Patients underwent ambulatory sleep testing for the diagnosis of OSA. Correlation and regression analyses were performed to detect the predictors of OSA.

Results: 100 participants with atrial fibrillation were recruited (72% Males). The mean age was 64 ± 13 years. Sleep related instruments showed that:

- Thirty-seven percent of patients have scores suggestive of excessive daytime sleepiness;
- Fifty-four percent have excessive daytime fatigue;
- Symptoms of non-restorative sleep are present in 57%;
- Twenty-five percent have scores suggestive of depression;
- Thirty-eight percent have mild insomnia, 14% moderate insomnia, and 5% severe insomnia;
- Six percent show scores suggestive of decreased alertness. Eighty-five percent of patients had previously undetected OSA. Only age and male gender were predictors of OSA (p=0.009, p=0.008 respectively).

Conclusion: Eighty-five percent of patients with atrial fibrillation have undetected OSA. Scores suggestive of daytime sleepiness, fatigue, insomnia, depression, and non-refreshing sleep do not predict OSA. Sleep studies may be applied routinely for detection of OSA in these patients.

Keywords: Obstructive sleep apnea; Atrial fibrillation; Insomnia; Depression; Non-restorative sleep; Excessive daytime sleepiness; Fatigue; Toronto hospital alertness test

Abbreviations: AHI: Apnea-Hypopnea-Index; BMI: Body-Mass-Index; CES-D: Center for Epidemiological Studies in Depression; ESS: Epworth Sleepiness Scale; FSS: Fatigue Severity Scale; ISI: Insomnia Severity Index; NRSS: Nonrestorative Sleep Scale; OSA: Obstructive Sleep Apnea; PSG: Polysonomography; THAT: Toronto Hospital Alertness Test

Introduction

Obstructive sleep apnea (OSA) is a sleep disorder associated with serious cardiovascular consequences [1,2]. OSA is characterized by recurrent upper airway obstruction during sleep, which results in hypoxia, hypercapnia and sympathetic over stimulation. OSA been recognized as risk factor for the development and progression of cardiac arrhythmia [3,4]. The vast majority of patients with OSA are still undiagnosed [5]. The classical symptoms of OSA include snoring, observed episodes of breathing cessation and choking during sleep, dry mouth and morning headache [6]. However, symptoms of OSA in patients with arrhythmia are often unrecognized. Patients with arrhythmia may show atypical symptoms of sleep and mood disturbance due to underlying unrecognized OSA. OSA may be associated with symptoms of excessive daytime sleepiness, fatigue, insomnia, and depression [7]. In addition, OSA is linked to poor cognitive function, poor concentration, and attention deficit [8,9]. These symptoms have significant dangerous consequences in regard to road safety and occupational health.
The incidence of motor vehicle accidents is two-to-five fold greater in patients with OSA than in age-matched controls [10]. Also, OSA is linked to occupational accidents as a consequence of insomnia or hypersomnolence caused by underlying OSA [11]. In addition, OSA adversely affects the cognitive function and concentration abilities in workers [11]. Therefore, it is important to detect and treat OSA in order to prevent or limit the adverse associated health and public safety consequences.

OSA remains undiagnosed in the majority of patients with cardiac arrhythmia. This is usually due to lack of consistent clinical predictors of OSA in these patients and low index of suspicion of OSA in these patients. Early identification and treatment of OSA in patients with arrhythmia may improve symptoms and decrease complications of cardiac arrhythmia [12]. Symptoms of insomnia, non-refreshing sleep, daytime sleepiness, fatigue, decreased alertness and depression are easily identifiable by physicians and, therefore, may assist in early detection of OSA.

In this study, we aimed to determine:

- The percentage of patients in outpatient arrhythmia clinics who show symptoms indicative of insomnia, non-refreshing sleep, excessive daytime sleepiness, fatigue, decreased alertness, and/or depression;
- The correlation of these symptoms to the severity of OSA as measured by the apnea-hypopnea-index (AHI); and
- If these symptoms predict the presence and/or the severity of OSA in these patients.

**Methods**

**Study design**

This was a prospective cohort study of patients presenting to three outpatient arrhythmia clinics in Toronto, ON, Canada. Ethical approval for the study was obtained from the University Health Network and St. Michaels Hospital Research Ethics Boards. Participants responded to questionnaires for assessment of daytime sleepiness, fatigue, insomnia, non-restorative sleep, depression, and alertness. Patients were evaluated for OSA by ambulatory sleep testing.

**Study population**

The study population included male and female adult patients (age ≥ 18 years). Patients had a previous documented diagnosis of cardiac arrhythmia. An informed consent was obtained from eligible patients. Patients with a previous diagnosis and/or treatment of OSA were excluded. Patients who have had a sleep study within six months prior to recruitment were also excluded.

**Administration of the study questionnaires**

The questionnaire package contained the following questionnaires:

**Epworth sleepiness scale:** The Epworth sleepiness scale (ESS) [13] is an eight-item questionnaire for the subjects to describe or estimate if they doze off inadvertently when engaged in activities involving low levels of stimulation, relatively immobile and relaxed [14]. The ESS estimates the average sleep propensity, and was found to distinguish patients with primary snoring from those with OSA [15]. The ESS has satisfactory re-test reliability (r=0.82), good internal consistency (α=0.88) [16], and has been shown to have satisfactory convergent validity when compared to the multiple sleep latency test [14]. The ESS is considered a reliable questionnaire to measure chronic sleepiness [16]. In this study, the ESS was used as a subjective measure of excessive daytime sleepiness. The ESS was scored by adding the scores of each item. The range of score is 0-24. A cut off score of 10 was used to distinguish patients with excessive daytime sleepiness.

**Fatigue severity scale:** The fatigue severity scale (FSS) [17] is a nine-item questionnaire that requires the subject to rate their own level of fatigue. The FSS has satisfactory test-retest reliability (r=0.99), excellent internal consistency (α=0.95), and satisfactory concurrent validity and discriminant validity between patients and controls [18]. The FSS has been validated in a depressed sample; however ceiling effects were described [18]. Higher scores on the FSS indicate higher daytime fatigue. In this study, the FSS was used as a measure of excessive daytime fatigue. The scoring was completed by calculating the average response to the questions (adding up all the answers and dividing by nine). Multiple cut-off values were used in this study including 3, 3.7, and 4.

**Insomnia severity index:** The insomnia severity index (ISI) is a seven-item questionnaire. It is a reliable and valid instrument to detect cases of insomnia in the population and is sensitive to treatment response in clinical patients. The ISI has excellent internal consistency (α=0.90), and adequate discriminatory capacity for 5 of the 7 items [19]. Convergent validity was supported by significant correlations between total ISI score and measures of fatigue, quality of life, anxiety, and depression. A cut-off score of 10 was 86.1% sensitive and 87.7% specific for detecting insomnia cases in a community sample [19]. In this study, the ISI was used to detect cases of possible insomnia. The scoring was completed by adding up the seven answers to get a total score. A score of 8–14 indicates mild insomnia, a score of 15–21 indicates moderate insomnia, and a score of 22–28 indicates severe insomnia.

**Non-restorative sleep scale:** The non-restorative sleep scale (NRSS) is a twelve-item questionnaire used to evaluate non-restorative sleep. Non-restorative sleep is defined as the subjective feeling that sleep has been insufficiently refreshing, often despite the appearance of physiologically normal sleep. Non-restorative sleep has been shown to be associated with a variety of cognitive, affective, and medical complaints. The NRSS has excellent internal reliability (α=0.88), and good test-retest reliability (r=0.72) [20]. A cut-off score of 46 or less is found to maximize sensitivity (0.91) while still providing satisfactory specificity (0.75). Higher scores indicate less severe non-restorative sleep. The NRSS was used to evaluate patients for symptoms of non-restorative sleep in this study. Scoring the NRSS was completed as follows:

- Reversing items 4, 5, 6, 7, 11, 12 before scoring;
- All items are given a weighted score from 1 to 5 (i.e. for scales ranging from 1-10, responses 1 and 2 are scored as 1, responses 3 and 4 are scored as 2, etc.);
- Adding up the scores of all the items. Global scores range from 12 to 60. A cut-off score of 46 was used.

**Center for epidemiological studies in depression scale:** The Center for Epidemiological Studies in Depression (CES-D) scale has been validated in clinical and community samples. The CES-D scale consists of 20 questions asked on a four-point Likert scale [21]. The CES-D scale consists of 4 subscales: Subscale 1: Somatic symptoms: 7 items (1, 2, 5, 7, 11, 13 and 20); Subscale 2: Depressed affect, 7 items (3, 6, 9, 10, 14, 17 and 18); Subscale 3: Absence of well-being, 4 items (4, 8, 12 and
and Subscale 4: Interpersonal affect, 2 items (15 and 19). Possible range is 0 to 60. A score of 16 or more is suggestive of depression. The CES-D should not be used as a clinical diagnosis of depression. The CES-D scale was used in this study to evaluate symptoms suggestive of depression among arrhythmia patients. The CES-D was scored by reversing the score of items 4, 8, 12, and 16, then adding the score of all items. The final score is the sum of the 20 items. A cut-off value of 16 was used.

**Toronto hospital alertness test:** The Toronto Hospital Alertness Test (THAT) is a rating scale of alertness that assesses a range of activities such as ability to concentrate; think of new ideas or focusing on the task at hand. THAT is a 10-item index designed to measure perceived alertness during the past week. Respondents rate all items on a 6-point scale, ranging from 0 (“not at all”) to 5 (“all the time”). The THAT scale has satisfactory test-retest reliability (r=0.79) and excellent internal consistency reliability (α=0.96) [22]. All items are considered equally important, yielding an additive score ranging from 0 (very low alertness) to 50 (very high alertness). The cut-off point is 20.5. Twenty (20) or lower on THAT suggests low alertness level. THAT was used to assess the level of alertness among patients with arrhythmia. Scoring was done by reversing the scores of the two final items (9 and 10), then adding all scores to get a total score. A cut-off score of 20 was used.

**Ambulatory sleep testing:** Patients underwent two consecutive night of home sleep recording using a portable sleep monitor (Somté PSG (v2), P/N: 8023-0001-02, Compumedics Limited, Australia). The sleep parameters included electroencephalogram, electro-oculogram, electromyogram, electrocardiogram, airflow, snore, respiratory effort, body position, limb movement, oxygen saturation, pulse rate and pulse waveform. The sleep studies were analyzed by certified sleep technologists and approved by a sleep specialist. The AHI values from the two nights were averaged to give a final AHI, which is used in the final analysis. The standard criteria of the American Academy of Sleep medicine were used in the scoring and analysis of the sleep parameters. The following standard criteria were used for the diagnosis of OSA: (1) mild OSA is an AHI ≥5 and <15/h TST; (2) moderate OSA is an AHI >15 and <30/h TST; and (3) severe OSA is an AHI >30/h TST.

**Statistical analysis**

The differences between patients with and without a diagnosis of OSA were assessed by the independent sample t-test for continuous variables and the chi-square test for categorical variables. A correlation analysis was performed to detect the correlation between symptoms of insomnia (ISI), non-restorative sleep (NRSS), excessive daytime sleepiness (ESS), decreased alertness (THAT), fatigue (FSS) and/or depressive symptoms (CES-D) and the AHI. A binary logistic regression analysis was performed to detect independent predictors of undiagnosed OSA in the study population.

**Results**

**The study sample characteristics**

A total of 100 patients with atrial fibrillation (70% males) were recruited. The mean age was 64 ± 13 years. The mean body mass index (BMI) was 28.7 ± 5.8 kg/m² (range: 17–47). Thirty-four percent of patients were obese (BMI ≥ 30 kg/m²). The mean neck circumference was 39.7 ± 3.7 cm. Tables 1 and 2 show the clinical comorbidities and the use of medications in the study sample.

**Table 1:** Clinical characteristics of the study sample; Values are expressed as percentage of total. Chi-square test was used to compare proportions of categorical variables. OSA: Obstructive Sleep Apnea; AF: Atrial Fibrillation; n: Number.

| Parameters                          | OSA (n=85) | Non-OSA (n=15) | Difference |
|-------------------------------------|------------|---------------|------------|
| Hypertension                        | 53%        | 27%           | P=0.06     |
| Diabetes                            | 12%        | 7%            | P=0.3      |
| Coronary Artery Disease             | 7%         | 7%            | P=0.9      |
| History of Stroke                   | 9%         | 0             | P=0.2      |
| Heart Failure                       | 3%         | 0             | P=0.4      |
| Hyperlipidemia                      | 42%        | 40%           | P=0.8      |
| Cardiomyopathy                      | 2%         | 0             | P=0.6      |
| Pacemaker insertion                 | 4%         | 0             | P=0.4      |
| Previous AF/flutter ablation        | 19%        | 27%           | P=0.4      |
| Cardiac valve replacement           | 2%         | 0             | P=0.5      |

| Parameters                          | OSA (n=15) | Non-OSA (n=85) | Significance |
|-------------------------------------|------------|---------------|--------------|
| Antidiabetic medication             | 9%         | 7%            | P=0.7       |
| Anticoagulant                       | 73%        | 20%           | P=0.000*    |
| Aspirin                             | 16%        | 27%           | P=0.2       |
| Digoxin                             | 8%         | 0             | P=0.2       |
| Beta-Blocker                        | 87%        | 13%           | P=0.007*    |
| ACE-I                               | 20%        | 0             | P=0.05      |
| ARBs                                | 12%        | 13%           | P=0.08      |
| Ca-Blocker                          | 29%        | 20%           | P=0.5       |
| Diuretics                           | 11%        | 0             | P=0.1       |
| Statins                             | 42%        | 20%           | P=0.1       |
| Antiarrhythmic                      | 29%        | 20%           | P=0.4       |
| Benzodiazepines                     | 5%         | 13%           | P=0.1       |
| Antidepressant                      | 7%         | 6%            | P=0.2       |

**Table 2:** Medication list of the study participants; Values are expressed as percentage of total. Chi-square test was used to compare proportions of categorical variables. * denotes significance. OSA: Obstructive Sleep Apnea; n: Number; ACE-I: Angiotensin Converting Enzyme Inhibitors; ARBs: Angiotensin Receptor Blocker; Ca-blocker: Calcium Channel Blockers.

**Assessment of sleep and mood in patients with arrhythmia**

Eighty-six patients completed the NRSS scale, 85 patients completed the ESS, FSS and ISI, and 84 patients completed the CES-D and THAT.
scales. For the total scores on the administered sleep and mood scales and a comparison between males and females see table 3. For a comparison of the scores between patients with and without OSA, see table 4. Table 5 shows the differences between male and female OSA patients.

| Parameters | Total | Males | Females | Difference |
|------------|-------|-------|---------|------------|
| ESS        | 6, 6 ± 4 | 5, 6 ± 3 | 8, 7 ± 4 | P=0.09     |
| ESS ≥ 10   | 22% | 18% | 32% | P=0.16     |
| FSS        | 3.1, 3.3 ± 1.4 | 3, 3.2 ± 1.4 | 3.4, 3.5 ± 1.4 | P=0.3     |
| FSS ≥ 3    | 54% | 52% | 60% | P=0.4     |
| FSS ≥ 3.7  | 33% | 32% | 36% | P=0.6     |
| FSS ≥ 4    | 31% | 28% | 36% | P=0.4     |
| ISI        | 9, 9 ± 6 | 7.5, 8 ± 6 | 11, 11 ± 6 | P=0.04*   |
| Mild insomnia | 38% | 37% | 40% | P=0.9     |
| Moderate insomnia | 14% | 10% | 24% | P=0.07    |
| Severe insomnia | 5% | 3% | 8% | P=0.3     |
| NRSS       | 45.5, 44 ± 8 | 46, 45 ± 8 | 39.1, 8 ± 8 | P=0.04*   |
| NRSS ≤ 46  | 57% | 54% | 64% | P=0.4     |
| CES-D      | 9.5, 11 ± 9 | 8, 10 ± 9 | 12, 14 ± 9 | P=0.03*   |
| CES-D ≥ 16 | 25% | 24% | 28% | P=0.8     |
| THAT       | 35, 35 ± 9 | 35.5, 36 ± 9 | 35.348 ± 8 | P=0.2     |
| THAT ≤ 21  | 6% | 5% | 8% | P=0.5     |

Table 3: The total scores and cut-off points suggestive of sleep or mood disturbance among the study sample. Values are shown as median, mean ± standard deviation, or percentage of total. Non-parametric tests were used to compare means of continuous variables. Chi-square test was used to compare proportions of categorical variables. *denotes significance. ESS: Epworth Sleepiness Scale; FSS: Fatigue Severity Scale; ISI: Insomnia Severity Index; NRSS: Non-restorative Sleepiness Scale; CES-D: Center for Epidemiologic Studies-Depression scale; THAT: Toronto Hospital Alertness Test.

| Parameters | OSA | Non-OSA | Difference |
|------------|-----|---------|------------|
| ESS        | 6, 6 ± 4 | 5, 6 ± 3 | P=0.4     |
| ESS ≥ 10   | 22% | 21% | P=0.9     |
| FSS        | 3.5, 3.5 ± 1.4 | 2.2, 2.5 ± 1.2 | P=0.024* |
| FSS ≥ 3    | 60% | 21% | P=0.005*  |
| FSS ≥ 3.7  | 38% | 14% | P=0.08    |
| FSS ≥ 4    | 35% | 14% | P=0.4     |
| ISI        | 9, 10 ± 6 | 4, 6 ± 6 | P=0.06    |
| Mild insomnia | 40% | 29% | P=0.4     |
| Moderate insomnia | 15% | 15% | P=0.9     |

Table 4: A comparison between the scores and cut-off points suggestive of sleep or mood disturbance in patients with and without OSA. Values are shown as median, mean ± standard deviation, or percentage of total. Non-parametric tests were used to test difference between groups. Chi-square test was used to compare proportions of categorical variables. *denotes significance. ESS: Epworth Sleepiness Scale; FSS: Fatigue Severity Scale; ISI: Insomnia Severity Index; NRSS: Non-restorative Sleepiness Scale; CES-D: Center for Epidemiologic Studies-Depression scale; THAT: Toronto Hospital Alertness Test.

| Parameters | OSA | Males | Females | Difference |
|------------|-----|-------|---------|------------|
| ESS        | 6, 6 ± 4 | 6, 6 ± 4 | 8, 8 ± 4 | P=0.03* |
| ESS ≥ 10   | 22% | 19% | 33% | P=0.2     |
| FSS        | 3.5, 3.5 ± 1.4 | 3.2, 3.4 ± 1.4 | 3.6, 4 ± 1.3 | P=0.1 |
| FSS ≥ 3    | 60% | 55% | 80% | P=0.07    |
| FSS ≥ 3.7  | 38% | 36% | 47% | P=0.4     |
| FSS ≥ 4    | 35% | 32% | 47% | P=0.2     |
| ISI        | 9, 10 ± 6 | 8, 9 ± 6 | 13, 13 ± 6 | P=0.026* |
| Mild insomnia | 40% | 40% | 40% | P=0.9     |
| Moderate insomnia | 15% | 11% | 27% | P=0.1     |
| Severe insomnia | 6% | 4% | 13% | P=0.1     |
| NRSS       | 44, 44 ± 9 | 45, 45 ± 8 | 38, 39 ± 9 | P=0.04* |
| NRSS ≤ 46  | 62% | 59% | 73% | P=0.3     |
| CES-D      | 9, 11 ± 9 | 8, 11 ± 9 | 11, 15 ± 11 | P=0.1 |
| CES-D ≥ 16 | 28% | 29% | 27% | P=0.8     |
| THAT       | 35, 35 ± 9 | 35, 35 ± 9 | 34.5, 32 ± 7 | P=0.2 |
| THAT ≤ 21  | 7% | 7% | 7% | P=0.9     |

Table 5: A comparison between the scores and cut-off points suggestive of sleep or mood disturbance among male and female patients with OSA; Values are shown as median, mean ± standard deviation, or percentage of total. Non-parametric tests were used to compare means of continuous variables. Chi-square test was used to compare proportions of categorical variables. *denotes significance. ESS: Epworth Sleepiness Scale; FSS: Fatigue Severity Scale; ISI: Insomnia Severity Index; NRSS: Non-restorative Sleepiness Scale; CES-D: Center for Epidemiologic Studies-Depression scale; THAT: Toronto Hospital Alertness Test.
for Epidemiologic Studies in Depression scale; THAT: Toronto Hospital Alertness Test.

**Evaluation of OSA in patients with arrhythmia**

Ambulatory sleep testing results were available for 100 patients who completed successful recordings. Of the total patients (n=100), 85% (72% males) met the diagnostic criteria for OSA (AHI ≥ 5/h of sleep). For patients with OSA; the mean age was 65 ± 13 years and the mean BMI was 29 ± 6. 40% of OSA patients were obese (BMI ≥ 30 kg/m²) and 12.5% were morbidly obese (BMI>35 kg/m²). The mean AHI for patients with OSA (n=85) was 23± 16/h, and the range was 5-90/h. 45% had mild OSA, 27% had moderate OSA, and 28% had severe OSA.

**Correlation analysis**

There was no correlation between age and any of the scores on the questionnaires. There was a negative correlation between male gender and CES-D score (p=0.03) and ISI score (p=0.04).

There was a positive correlation between the FSS score and the BMI (p=0.02) and the AHI (p=0.02). However, there was no correlation between the FSS score and the BMI after adjusting for the BMI (p=0.2). None of the other scores correlated with the AHI. Age and BMI had a positive correlation with the AHI (p=0.009, p=0.000 respectively) even after adjusting for all other confounders. There was no correlation between gender, neck circumference and the AHI.

**Regression results**

Multiple regression showed that age and the BMI were independent predictors of the AHI (p=0.03, p=0.000 respectively), which represents the severity of OSA.

Binary logistic regression analysis showed that total scores on ESS, ISI, NRSS, CES-D, and THAT were not predictors of OSA. In addition, the cut off scores were not predictors of OSA. The total FSS score was a predictor of OSA after adjusting for age, BMI, gender, and scores on the ESS scale (Odds ratio=4, p=0.006). However, after adjusting for the scores on the CES-D, NRSS and THAT, the total FSS score was not a predictor of OSA (p=0.2). Similarly, a score of ≥ 3 on the FSS was not a predictor of OSA. Only age and male gender were significant independent predictors of OSA (p=0.009, p=0.008 respectively).

**Discussion**

In this study, patients with atrial fibrillation and previously unknown OSA status had high levels of fatigue (54%), insomnia (57%), non-refreshing sleep (57%), and depression (25%), but surprisingly not decreased alertness (6%). Compared to males, females had significantly higher scores suggestive of insomnia, non-refreshing sleep and depression.

Further, patients with OSA had increased scores suggestive of excessive daytime sleepiness (22%), fatigue (60%), insomnia (61%), non-restorative sleep (62%), depression (25%), and decreased alertness (7%). The only significant difference between patients with and without a diagnosis of OSA was the FSS scores. Female patients with OSA had significantly different scores suggestive of excessive daytime sleepiness, insomnia, and non-restorative sleep compared to male patients with OSA. It is important to note that female patients may express insomnia and/or non-refreshing sleep rather than the typical symptoms of OSA. Fatigue, sleepiness, insomnia, non-refreshing sleep and depression symptoms may arise due to variety of factors. Medical comorbidities and the use of several medications may contribute to some degree to these symptoms. In addition, sleep and mood symptoms may reflect an underlying OSA or at least OSA may influence the severity of these symptoms. Surprisingly, in our study sample there was no correlation between the scores on the administered sleep and mood scales and the severity of OSA. Moreover, none of these symptoms predicted the presence of OSA in this population. However, this may be limited by the sample size, and selection and observational bias. Nevertheless, this study may be the first step to help recognition of sleep and mood symptoms in arrhythmia patients in order to build up a clinical profile that may characterize patients with underlying OSA. The next step would involve determination of a clinical phenotype of patients with OSA and arrhythmia, which may help defining a specific clinical and therapeutic approach. This in turn may help in early detection and appropriate treatment of OSA in these patients.

In conclusion, OSA is common and undetected in patients with atrial fibrillation. Scores suggestive of insomnia, non-refreshing sleep, excessive daytime sleepiness, fatigue, decreased alertness and depression did not predict the presence of OSA in these patients. Therefore, patients with atrial fibrillation, regardless of relevant symptoms, may require a sleep study for detection of OSA.

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**Conflict of Interest**

CS has shares in the Neurozone MSH Inc. that provided the ambulatory sleep apparatus. AA, PD, DN have no conflict of interest to disclose.

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