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A Retrospective Analysis of Patients with Pulmonary Hypertension to Assess the Role of Overnight Oximetry in the Diagnosis of Sleep Disordered Breathing

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Abstract

Background: In patients with Pulmonary Hypertension (PH), the role of overnight oximetry as means to screen for Sleep Disordered Breathing (SDB) has not been well established. The aim of this study was to assess whether overnight oximetry was additive to a standard sleep questionnaire in the diagnosis of SDB.

Methods: This retrospective study included 94 PH patients seen at Mayo Clinic Florida PH Center from 1992 to 2006. Analysis was performed on the following information: age, gender, body mass index, presence of hypertension, right ventricular systolic pressure (RVSP), presence of SDB symptoms (i.e. snoring, excessive daytime sleepiness, witnessed sleep apneas), overnight oximetry results, and polysomnography results when available. The primary outcome measurement was the correlation between SBD symptoms (snoring, excessive daytime sleepiness, and witnessed sleep apnea) and results of overnight oximetry.

Results: There is strong evidence showing a higher prevalence of abnormal overnight oximetry results as the number of SDB symptoms increases (P<0.001). Of patients who had no symptoms of SDB (17), all oximetry results were found to be normal. The clinical symptoms of SDB were 100% sensitive for an abnormal screening overnight oximetry. Other analysis revealed evidence of a higher prevalence of snoring in men (P=0.005) and in patients with a higher BMI (P=0.038).

Conclusions: In PH patients who have a few or no symptoms of SDB, an overnight oximetry is not additive in screening for SDB. In those patients with SDB symptoms, an overnight oximetry will be predictably abnormal.

Keywords

Pulmonary arterial hypertension, Sleep disordered breathing, Overnight oximetry

Introduction

Sleep Disordered Breathing (SDB) is a known risk factor in the development of Pulmonary Hypertension (PH) [1]. In patients with PH, the role of overnight oximetry as a means to screen for SDB has not been well established [2]. Current recommendations are based on studies that have shown a high prevalence of nocturnal desaturation in patients with pulmonary arterial hypertension [3,4]. The presence of sleep apneas and hypopneas has been found to be rare when measured during polysomnography [3]. Nonetheless, the prevalence of patients with both SDB and PAH has been estimated at as high as 17 to 53% [5].

There exists evidence that overnight oximetry is a sensitive means of screening individuals for the presence of SDB [6,7]. To date this data has not been extrapolated to patients with PH. In this study, we sought to evaluate whether overnight oximetry was additive to a standard sleep questionnaire in the diagnosis of SDB in patients with PH.

Materials and Methods

Patients

This study was approved by the Mayo Clinic Institutional Review Board. All patients seen at the Mayo Clinic Florida PH clinic from 1992 to Sept 2006 were studied retrospectively. A total of 318 patients were identified for analysis. The following number of patients were excluded from analysis: 183 patients because an overnight oximetry was not obtained at time of initial evaluation; 27 patients who were on oxygen at time of overnight oximetry; 4 patients who were being treated with non-invasive positive pressure therapy at the time of evaluation; 2 patients who had less than 4 hours of recording of overnight oximetry; and 2 patients who were found to have a normal Right Ventricular Systolic Pressure (RVSP) as measured by echocardiogram.

Data collection

The following information was collected at the time of initial

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evaluation from 94 PH patients: age, gender, Body-Mass Index (BMI), presence of systemic hypertension, RVSP, symptoms of SDB (snoring, excessive daytime sleepiness or witnessed apneas), overnight oximetry result, oxygen saturation level, partial pressure of oxygen in arterial blood, Polysomnography (PSG) test results, percent predicted Total Lung Capacity (TLC), percent predicted forced expiratory volume in 1 second (FEV1), FEV1/ Forced Vital Capacity (FVC), and percent predicted diffusing capacity for carbon monoxide (DLCO).

RVSP was estimated by echocardiogram via peak tricuspid regurgitant jet velocity. Pulmonary function studies were obtained in a standard fashion having met American Thoracic Society criteria. Overnight oximetry was obtained with PROFOX Oximetry version: Standard ST103.14-2687 software and the Nonin 2500 PalmSAT memory, 4 second resolution oximeter. A qualitative and quantitative assessment of the tracing and data was made for interpretation. Quantitative data reviewed included time with SpO2 < 90%, number of desaturations with a drop in saturation > 4%, and mean SpO2. Severity of SDB was based on the Oxygen Desaturation Index (ODI), calculated by the number of desaturations divided by reported hours of sleep. Reporting of results was either: normal, baseline hypoxemia (mean SpO2 < 91%), or a number representing the ODI. ODI < 15 was defined as normal, 16 to 30 as mild SDB, 31 to 45 as moderate SDB, and > 45 as severe SDB.

Statistical analysis

Numerical variables were summarized with the sample median, 25th percentile, and 75th percentile. Categorical variables were summarized with number and percentage. Kendall's correlation coefficient tau or a Cochran-Armitage trend test was used to investigate associations between patient characteristics and both overnight oximetry result as well as number of SDB symptoms. Kendall's correlation coefficient tau or a Cochran-Armitage trend test was used to examine associations between pulmonary function test information and overnight oximetry result. Odds Ratios (OR's) and corresponding 95% Confidence Intervals (CI's) from single variable logistic regression models were used to investigate associations between patient characteristics and individual SDB symptoms.

Logistic regression models were used to investigate the association between overnight oximetry test result and number of SDB symptoms; various dichotomizations of overnight oximetry result were considered. Sensitivity to the possible confounding effects of other variables was also considered; based on the relatively small sample size, no more than one variable in addition to number of SDB symptoms was included in any one model. Statistical significance was determined at the 5% level. No adjustments for multiple comparisons were made in these exploratory analyses.

Results

318 patients were reviewed of which 94 met inclusion criteria. Baseline patient characteristics are shown in Table 1. Of the 94 patients, 17 (18%) had abnormal overnight oximetry suggesting the presence of SDB. Low baseline hypoxemia was found in 23 (24%) of patients, and normal studies were found in 54 (57%) subjects.

There is strong evidence showing a higher prevalence of abnormal overnight oximetry results as the number of SDB symptoms increases (P<0.001). Of patients who had no symptoms of SDB (17), all oximetry results were found to be normal (Table 2).

The clinical symptoms of SDB were 100% sensitive for predicting an abnormal screening overnight oximetry (Table 3).

A PSG was performed on 18 of the 94 patients. Of the14 patients with abnormal PSG results, only one subject had a normal overnight oximetry (Table 4).

Associations between patient characteristics and number of SDB symptoms are shown in Table 5. Other analysis revealed evidence of a higher prevalence of snoring in men (P=0.005) and in patients with a higher BMI (P=0.038). There is no statistically significant evidence of any other associations between patient characteristics and either individual SDB symptoms or overnight oximetry results.

Other analysis revealed evidence of a lower oxygen saturation level, lower partial pressure of oxygen in arterial blood, lower DLCO, and lower TLC in patients with low baseline oximetry results (Table 6).

Table 1: Patient characteristics.

Variable	Summary (N=94)
Age	69 (25–75)
Gender	
Male	34 (36%)
Female	60 (63%)
BMI	29.0 (24.7–32.6)
Echo RVSP	71 (57–82)
Snoring	50 (53%)
Excessive daytime sleepiness	22 (23%)
Witnessed sleep apnea	12 (13%)
Systemic Hypertension	55 (59%)
- The sample median (25th percentile, 75th percentile) is given for numerical variables.	

Table 2: Associations between individual sleep disordered breathing symptoms and overnight oximetry test result.

	Overnight oxymetry test result			
SDB symptom	Normal (N=54)	Low baseline oxygen (N=23)	Abnormal (N=17)	P-value
Snoring	24 (44%)	11 (48%)	15 (88%)	0.004
Excessive daytime sleepiness	8 (15%)	4 (17%)	10 (59%)	<0.001
Witnessed sleep apnea	5 (29%)	0 (0%)	5 (29%)	0.28
- P-values result from Kendall's correlation coefficient tau or a Cochran-Armitage trend test.				

Table 3: Estimated sensitivity and specificity of number of SDB symptoms for predicting an abnormal overnight oximetry.

Number of SDB symptoms	Estimated sensitivity	95% CI	Estimated specificity	95% CI
1-3	17/17 (100%)	80% - 100%	42/77 (55%)	43% - 66%
2-3	8/17 (47%)	23% - 72%	62/77 (81%)	70% - 89%
3	5/17 (29%)	10% - 56%	73/77 (95%)	87% - 99%
- An exact binomial 95% confidence interval (CI) is given for each estimated sensitivity and specificity.				

Table 4: Overnight oximetry result and polysomnography result.

Overnight oximetry result	Normal (N=4)	Abnormal (N=14)
Normal	3 (75%)	1 (7%)
Low baseline oxygen levels	0 (0%)	2 (14%)
Abnormal	1 (25%)	11 (79%)

Table 5: Associations between patient characteristics and number of sleep disordered breathing symptoms.

	Number of SDB symptoms				
Variable	0 (N=42)	1 (N=29)	2 (N=14)	3 (N=9)	P-value
Age	68 (59–74)	70 (61–73)	72 (52–79)	67 (60–78)	0.67
Gender					0.013
Male	8 (19%)	15 (52%)	6 (43%)	5 (56%)	
Female	34 (81%)	14 (48%)	8 (57%)	4 (44%)	
BMI	27.0 (23.3–30.8)	29.2 (26.1–33.4)	31.3 (27.0–33.6)	32.9 (28.0–45.9)	0.010
Echo RVSP	68 (57–84)	74 (59–82)	69 (46–77)	74 (72–79)	0.71
Sytemic Hypertension	22 (52%)	19 (65%)	8 (57%)	6 (67%)	0.73
- P-values result from Kendall's correlation coefficient tau or a Cochran-Armitage trend test.					

Discussion

During routine evaluation of patients with PH, an assessment for the presence of SDB is recommended. [1]. Whether this assessment

Table 6: Overnight oximetry test result – associations with pulmonary function tests.

Variable	Normal (N=54)	Low baseline oxygen (N=23)	Abnormal (N=17)	P-value
Oxygen saturation level (%)	96 (95–97)	94 (92–96)	95 (93–96)	<0.001
Partial pressure of oxygen in arterial blood (%)	72 (65–79)	64 (58–67)	66 (58–73)	0.021
Percent predicted total lung capacity (%)	88 (76–101)	80 (67–96)	80 (66–90)	0.019
Percent predicted FEV1 (%)	68 (55–79)	67 (45–75)	66 (50–86)	0.56
FEV1/FVC	73 (66–77)	74 (67–83)	79 (74–84)	0.030
Percent predicted DLCO (%)	67 (57–81)	55 (45–72)	56 (37–72)	0.045
- P-values result from Kendall's correlation coefficient tau or a Cochran-Armitage trend test.				

should consist of a questionnaire, overnight oximetry, or PSG is unknown. One such recommended approach would be to obtain an overnight oximetry if evidence of daytime resting or exercise desaturation exists. Subsequently, if the overnight tracing reveals a "sawtooth" pattern and patient has risk factors such as snoring, excessive daytime sleepiness, witnessed apneas, obesity, systemic hypertension, or old age then one should proceed on to full PSG [8,9].

We found that in patients with PH, clinical screening may suffice as the initial tool to screen for the presence of SDB. When symptoms were present, overnight oximetry added little to the diagnosis of SDB. In the absence of symptoms, there were no abnormal overnight oximetry results [10].

Proponents for the use of overnight oximetry often argue that it aids in the diagnosis of nocturnal hypoxemia. A small study of 13 primary PH patients reported that 10 (77%) had significant nocturnal hypoxemia, which were unrelated to apneas and hypopneas [3]. A second study of 43 patients with pulmonary arterial hypertension demonstrated that 70% had at least 10% of the night with an oxygen saturation of less than 90% [4]. Our subset of patients did not show nearly such high a prevalence, with only 24% of patients found to have nocturnal hypoxemia. These 23 patients tended to have lower baseline oxygen saturation (94% vs 96%), as well as lower resting PaO_2 (65 vs 71 mmHg). Also these patients were found to have a lower % predicted DLCO (57% vs 68%). Perhaps alternative measures (i.e. resting or exercise induced hypoxemia, low DLCO etc.) could be used as clues to identify those at high risk for nocturnal hypoxemia, thus increasing the pretest probability of further testing by overnight oximetry.

Of the subset of patients (18) who were prompted to undergo PSG based on an abnormal oximetry or history suggestive of SDB, a majority 14 (77.8%) were found to have an abnormal study (Apnea/Hypopnea Index>5). All patients who had SDB confirmed by an abnormal PSG had at least one symptom suggestive of SDB (i.e. snoring, excessive daytime sleepiness, witnessed apneas). Only a single patient was reported to have a normal overnight oximetry, and found to have an abnormal PSG. Of note, this patient did report symptoms of snoring, excessive daytime sleepiness, and witnessed apneic events. The PSG confirmed mild SDB (AHI 8.3) despite normal overnight oximetry. The experience with this patient emphasizes the point that in patients who have a clinical history suggestive of SDB, proceeding to PSG may be the correct course of action, rather than obtaining an overnight oximetry.

Limitations of our analysis include the single center, retrospective design and lack of a control group to non-PH patients. Also the population was drawn from a tertiary referral practice and may not reflect a general medical practice. The diagnosis of PH was based on ECHO estimates of RVSP and not all patients underwent the standard of RHC [2]. Finally, not all patients underwent PSG which remains the standard in diagnosis of SDB.

Conclusion

Future practices may consider exclusion of routine overnight oximetry as the initial screening tool for SDB in the evaluation of patients with PH. Overnight oximetry may still have a role in the initial evaluation of nighttime basal hypoxemia if suspected by history and physical examination.

In PH patients who have no symptoms of SDB, an overnight oximetry may not be additive in screening for SDB. In those patients with SDB symptoms, an overnight oximetry will be predictably abnormal.

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