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Research Article

Improving the Identification and Triage of Patients with Obstructive Sleep Apnea Who Require Treatment: The Merlin Tool for High Risk Populations

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ABSTRACT

Aims and objectives: A number of validated questionnaires are routinely used to screen specific populations for obstructive sleep apnea (OSA) including the STOP, STOP-Bang, Berlin and Epworth sleepiness scales. These questionnaires depend on subjective questions which cannot be independently confirmed. The subjective questions also result in high sensitivity and low specificity as they are generally resulting from OSA. The aim of the study was to identify verifiable and independently measurable risk factors and increase specificity to limit the number of polysomnography evaluations (PE) and lower healthcare cost.

Methods: A retrospective data collection of patients (N=164) enrolled for PE was performed which included the results of STOP, STOPBang, Berlin and Epworth questionnaires as well as demographic and health related variables. OSA was defined as an AHI>=15 obtained from an overnight PE. Sensitivity and specificity of each questionnaire as well as for combinations of other, independently verifiable factors (IVF) was calculated. A new questionnaire was devised including the IVFs and data was prospectively collected from patients undergoing PE (N=209).

Results: The retrospective analysis identified age>50, male, BMI>30, alcohol consumption>21 per week, collar circumference>16 inches (40cm), diabetes, use of antidepressants and high blood pressure as the most influential factors. Prospective data collection was performed and analysis resulted in a new scale with a cut off of 3 based on the following equation: OSA=(2*BMI>30)+(Age>50)+(Male)+(neck>16)+(diabetes)+(alcohol>21unit/week). For every 100 patients with OSA, the total number enrolled for PE based on each screening tool were respectively for STOP 92 enrolled of whom 41 were diagnosed and 1 patient missed, for STOP-Bang 94 enrolled, 42 identified and 1 missed, Berlin 83 enrolled, 36 identified and 7 missed, Epworth 46 enrolled, 22 identified and 20 missed and our new screening tool 65 enrolled, 35 identified and 8 missed.

Conclusion: In a high risk population of patients referred for PE we identified independently verifiable factors associated with OSA and with only 2/3 of patients enrolled for PE, we identified most OSA cases while keeping the number of missed cases down.

Keywords: Obstructive sleep apnea; Polysomnography; Epworth sleepiness scales; Merlin Tool

INTRODUCTION

Increased awareness amongst general practitioners, non-respiratory physicians and the general population of the risks associated with obstructive sleep apnea (OSA) has led to an increase in the volume of referrals requesting polysomnography evaluations in our sleep clinic. There are a number of validated

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questionnaires which are routinely used to screen specific populations for OSA including the STOP, STOP-Bang, Berlin and Epworth sleepiness scales [1-3]. These questionnaires include subjective questions which cannot be independently confirmed. For instance, snoring which has a higher chance of being reported when the patient has a partner. These subjective questions result in a high sensitivity and low specificity as they are often indicative of OSA.

The aim of the presented study was to identify verifiable and independently measurable risk factors to increase specificity and limit the number/prioritize patients for polysomnography exams (PSG). These improved risk factors will improve independent identification of patients that will likely need treatment which in turn will lower healthcare cost. Our study population included patients whom already had been referred to the sleep clinic and therefore can be considered as a high risk population.

Methods

A retrospective data collection recorded all information from patients presenting at the sleep clinic with suspected OSA during 2013. For each patient, the following variables were collected: age, sex, blood pressure, BMI, smoking, alcohol intake, neck circumference, history of asthma, COPD, diabetes and other comorbidities, use of antidepressants and other medications. Each patient also filled out the STOP (-bang), Berlin and Epworth sleepiness scales. Based on the above retrospective data collection and subsequent analysis, a prospective group was then enrolled and our Merlin tool was used to screen for OSA.

Moderate OSA was defined as an AHI>=15 obtained from an overnight PSG. Sensitivity and specificity of each questionnaire as well as for combinations of independently verifiable factors (IVF) were calculated and compared to obtain the most advantageous combinations to maximise specificity without compromising sensitivity too much. Numbers of false positive patients (questionnaire indicates OSA but AHI<15) and false negative patients (questionnaire dismisses OSA but AHI>+15) were calculated to compare the number of missed cases. A diagnostic odds ratio (dOR) was calculated using a 2 by 2 table. The dOR indicates how many times more often a positive test result occurs among patients with the condition of interest compared to patients without the condition. Data was entered in Excel and statistical analysis was performed using IBM-SPSS v22 for Windows.

Ethical approval was sought and obtained from the Health Service Executive, University Hospitals Galway Ethical committee.

RESULTS

Data was collected retrospectively from a total of 164 patients who were already enrolled for PSG. Data collection included the results of STOP, STOP Bang, Berlin and Epworth questionnaires as well as demographic and health related variables (Table 1).

	N	%	Of whom needed treatment	%
Age ≥ 50	190	61	85	45
Male	224	72	99	44
BMI>35	130	42	71	55
BMI>30	207	67	101	49
Neck ≥ 16cm	211	70	99	47
Smoker	63	20	24	38
Diabetes	43	14	25	58
CHD	35	11	20	57
Nasal	49	34	24	49
ORO ≥ 3	56	39	33	59
Asthma	40	13	14	35
COPD	17	5	11	65
Antidepressants	77	25	31	40
Alcohol>21units	11	6	7	64

Table 1: Demographics.

The prevalence of patients requiring treatment for OSA was 35.5%. The STOP questionnaire had a sensitivity of 93.2% and specificity of 6.8%, the STOPBANG questionnaire had a sensitivity of 100% and specificity of 5.1%, the Berlin questionnaire 98.3% and 11.3% respectively and the Epworth questionnaire resulted in 70.2% sensitivity and 39.8% specificity. Based on different combinations of IVFs, BMI, age, sex, neck circumference, diabetes and alcohol consumption, antidepressant use and high blood pressure were identified as the most influential IVFs.

This score was subsequently optimized using prospectively collected data of all new patients undergoing PSG (N=209) in the sleep clinic. Prevalence of OSA requiring treatment was 42.6%. The final Merlin score was based on the following factors each accounting for 1 point except for BMI >30 which was given 2 points: age>50, male sex, BMI>30 (2 points), alcohol consumption>21 per week, collar circumference>16 inches (40cm). A Merlin score equal to or over 3 was indicative of OSA. The Merlin tool reached a sensitivity of 77.3% and specificity of 48.2% while the other tools changed slightly (Table 2).

Merlin Score=(2*BMI>30)+(Age>50)+(Male)+(neck>16)+(diabetes)+(alcohol>21unit/week).

For every 100 patients with OSA, the total number enrolled for PSG based on each screening tool were respectively 92 for STOP of whom 41 (45%) were diagnosed and 1 patient missed, 94 for STOP-Bang of whom 42 were diagnosed (45%) and 1 missed, 83

for Berlin of whom 36 (43%) diagnosed and 7 missed, 46 for Epworth of whom 22 (48%) were diagnosed and 20 missed and our new Merlin tool that enrolled 65 patients of whom 35 (54%) diagnosed and 8 missed. Table 2 shows an overview of the sensitivity and specificity of each tool as well as the dOR at the indicated prevalence. In the presented population, with a high prevalence of OSA, only the dOR of the Merlin tool is significant (3.2 (1.6-6.2)) while the other dORs all include 1 in their confidence interval (no difference). This indicates that in the presented population, the chance of a positive diagnosis based on the Merlin tool give you a 3.2 higher chance of being diagnosed with OSA. The outcome of the other tools is no different between those who do and those who do not have OSA.

Table 2: Overview of the sensitivity and specificity of each tool as well as the dOR at the indicated prevalence.

Screening tool	Sensitivity %	Specificity %	Number enrolled for PSG	Number with OSA	Number missed	dOR	CI
Merlin	77.3	48.2	123	51	15	3.2	1.6-6.2
STOP							
Retrospective	93.2	6.8	151	55	4	1	0.3-3.6
Prospective	93.7	9.5	135	59	4	1.5	0.4-5.4
STOPBANG							
Retrospective	100	5.1	151	58	0	6.7	0.4-426.8
Prospective	96.8	9.5	137	61	2	3.2	0.7-15.7
BERLIN							
Retrospective	98.3	11.3	151	57	1	7.3	0.9-57.5
Prospective	82.5	16.7	122	52	11	0.9	0.4-2.3
Epworth							
Retrospective	70.2	39.8	102	40	17	1.6	0.8-3.1
Prospective	52.5	56.1	67	31	28	1.4	0.7-2.8

DISCUSSION AND CONCLUSION

Questionnaires for evaluation of OSA are used routinely as part of the sleep history in most sleep centers in the world. Due to the subjective nature of these questionnaires the effectiveness for identifying patients with OSA limits their clinical use. Efforts have been made to try and increase the specificity and sensitivity by modifying questionnaires in the past with marginal improvements.

There have been a number of studies which sought to assess the diagnostic accuracy of the various sleep questionnaires. El-Sayed et al. [4] looked at an Egyptian population of 234 patients and evaluated the sensitivities and specificities of the questionnaires. For moderate-severe OSA (AHI >15 and =/<30 n=177) they found the following STOP BANG (Sensitivity 97.74%, Specificity 3.7%), STOP (Sensitivity 94.35%, Specificity 25.93%), Berlin (Sensitivity 95.48%, Specificity 7.41%) and ESS (Sensitivity 75.7%, Specificity 48.15%). This population specific study's results were similar to our own in that the Epworth score had the highest specificity but the lowest sensitivity.

Hsiao-Yean Chiu et al. in 2016 [5] performed a meta-analysis to assess the diagnostic accuracy of the various sleep questionnaires according to severity of OSA. For moderate-severe OSA (AHI>15 and =/<30 n=177) they found the following STOP BANG (Sensitivity 90%, Specificity 36%), STOP (Sensitivity 89%, Specificity 32%), Berlin (Sensitivity 77%, Specificity 44%) and ESS (Sensitivity 47%, Specificity 62%). They found for studies which included a sleep clinic specific population there was a higher pooled sensitivity for the questionnaires. They found that the diagnostic odds ratio for the STOP BANG questionnaire was superior to the Berlin, ESS and STOP questionnaires.

We aimed to simplify the triage process by identifying independently identifiable factors which would improve diagnosis. We found a score of 3 or more on the Merlin tool helps independent diagnosis and increased the chance that a patient suspected of sleep apnea would have the condition with the need for treatment.

Limitations of our study are that the patients enrolled are already deemed high risk as they are attending a sleep clinic and

referred for PSG, which is reflected in the high prevalence of OSA. The population size is also small and it would be interesting to see if using the Merlin tool in general practice would improve the triage of patients into the sleep clinic.

In a high risk population of patients referred for PSG we identified independently verifiable factors associated with OSA and only enrolled 65 out of every 100 of patients for PSG without an alarming increase in the number of missed cases. The other tools generally enrolled more than double the number of patients for PSG, resulting in a significant increased economic cost. A subsequent prospective conformation of our tool is currently being performed with the aim to maximize OSA identification while keeping costs down. Our current routine outpatient waiting time to be seen in a sleep clinic is approximately 18 months. With the implementation of the Merlin tool improved triage sleep referrals can be accomplished prioritizing those that will likely need treatment and reducing waiting times.

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