

Berlin Questionnaire and Portable Monitoring Device for Diagnosing Obstructive Sleep Apnea: A Preliminary Study in Jakarta, Indonesia

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Abstract

Study objective: to evaluate patients who came with the history of snoring with Berlin Questionnaire and sleep study using portable monitoring device.

Setting: Mitra International Hospital, Jakarta, Indonesia.

Material and methods: This was a preliminary study in 15 patients who came to the Respiratory Clinic with the history of snoring and suspicion of having obstructive sleep apnea (OSA). They were intended to undergo a sleep study using a portable device (PM). All patients were screened with Berlin Questionnaire and continued with application of portable monitoring device for one night stay at the hospital. Parameters recorded during examination were body mass index (BMI), apnea/hypopnea index (AHI), oxygen saturation, oxygen desaturation during sleep and lowest oxygen desaturation during sleep.

Results: There were 14 (93.3%) male and only 1 female (6.7%) joined the study; the mean age was 48.93 year old, with age ranged between 16-74 year old. Only 2 patients with BMI 18-23 and 13 others had BMI \geq 23. Three patients were not assessed by Berlin Questionnaire, 1 patient was disconnected from oxygen accidentally during sleep. From 12 patients screened with Berlin Questionnaire, 9 patients (75%) had high risk

and 3 patients (25%) had low risk. Based on AHI, there were 4 patients with AHI \leq 5, 3 patients with mild OSA (AHI 5-15), 3 patients with moderate OSA (AHI 15-30), and 5 patients had severe OSA (AHI $>$ 30).

Oxygen saturation recorded by pulse oxymeter (SpO₂) ranged between 81.6% to 98.0%, while the lowest SpO₂ during sleep ranged between 68.0% to 89.1%. Oxygen desaturation (OD) ranged between 4.40% to 9.40%.

Only 4 patients (2 moderate OSA, 2 severe OSA) can be followed of using continuous positive airway pressure (CPAP) machine after the test. There was improvement in patient using CPAP. In patients with severe OSA, AHI improved to 5-15, while in moderate OSA AHI was improved to $<$ 5.

Conclusion: Berlin Questionnaire is quite reliable to determine which patient need further evaluation of OSA and portable monitoring device may be used for diagnosing sleep apnea since in 4 patients with moderate (AHI 15-30) and severe OSA (AHI $>$ 30) were all improved with CPAP. Based on this preliminary study, portable monitoring device can be used in the situation where no sleep laboratory available or in patient refused to be assessed with attended full polysomnography.

Keywords: sleep apnea, Berlin Questionnaire, apnea/hypopnea index, oxygen saturation, portable monitoring device, continuous positive airway pressure (CPAP).

Introduction

Breathing process in normal awake human at rest or during exercise is perfectly engineered that each breath is produced with minimum energy cost to the respiratory muscles and a precise regulation of O₂ and CO₂ in arterial blood [1]. Disturbance in this regulatory system will give even systemic effects [2]. A sigh, changes in posture, prolonged expiration, swallowing, changes in air-

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way caliber or exercise will only cause momentary disrupting [1].

Obstructive sleep apnea syndrome (OSA) is a sleep and breathing disorder characterized by recurrent episodes of partial or complete upper airway obstruction during sleep [3]. Pharyngeal anatomy, upper airway muscle responsiveness during sleep, arousal threshold and loop gain may contribute to apnea presence and severity [4]. The obstruction episodes should happen at least 5 episodes per hour (of more than 10 second apnea) plus compatible symptom such as excessive daytime sleepiness. This episode is called as apnea/hypopnea index (AHI). Apnea/Hypopnea Index (AHI) 5-15 is considered as mild OSA, AHI 15-30 is moderate OSA and AHI >30 is severe OSA [3,5]. Obstructive sleep apnea (OSA) then, considered to be connected in the pathogenesis of systemic diseases particularly cardiovascular diseases [6,7].

Redline [2] reported that the prevalence of hypertension is higher in obstructive sleep apnea syndrome (OSAS) patients. Interestingly that the prevalence is connected with AHI; 43% when the AHI is <15, 62% for AHI 15-29 and 67% in AHI >30 [2]. The risk of cardiovascular disease (CVD) (coronary artery disease and cerebrovascular disease) is also increase 30-40% in AHI >12 [2]. However, daytime sleepiness is one of the most commonly disorder found in OSAS, 8% in AHI 5-<15, 15% in AHI 15-<30 and 29% in AHI >30 [2].

The problem is lack of awareness of the nonspecific signs and symptom of sleep apnea. Patient maybe unaware that they might have serious problem because they did not know what was happening during their sleep [8]. The high prevalence of undiagnosed OSA in the general adult population is now established [1], and Young *et al* [9] estimated that 93% of women and 82% of men with moderate to severe OSAHS (obstructive sleep apnea hypopnea syndrome) are not diagnosed. Sleep apnea itself is more often encountered in men [10]. In women, postmenopausal women are at higher risk for OSA compare to premenopausal [5,7,11].

Diagnosis of OSA is based on clinical symptoms and on the demonstration of abnormal breathing during sleep, usually by in-hospital cardiorespiratory polysomnography [9,12,13].

Polysomnography is the ideal method for diagnosis of sleep apnea. Other alternative diagnostic strategy is the use of portable monitoring (PM) device (attended or unattended). Anyhow, various studies also found limitations in some PM due to inadequate data collection or possibility of loosing some important data that will influence the accuracy of the diagnosis [14,15].

Arterial oxyhemoglobin saturation (SaO₂) has proved to be a useful measurement in diagnosing conditions and following up patients with sleep apnea, chronic obstructive pulmonary disease (COPD) and a variety of other respiratory disorders [15]. Oxygen desaturation are common with obstructive sleep apneas but can be absent with hypopneas or in events with increased upper airway resistance [9].

Material And Methods

Subjects

The study was done in 15 patients who came to the outpatient Respiratory Clinic, Mitra International Hospital, Jakarta, Indonesia. The patients who were asked to join the study all came with chief complaint of snoring, from August 2005 to September 2006. From 15 patients who agreed to join the study, 14 were male and only 1 female. The range of age was between 16 to 74 years and suspected of suffering sleep apnea syndrome. Body Mass Index (BMI) was assessed by using body weight and height data of the patient. All patients were screened with Berlin Questionnaire and continued with the application of portable monitoring device (PM). The PM that used was Embletta PDS X-30 with 8 sensors (internal sensors for body position/actigraph, pressure sensor and external sensors for respiratory effort sensors, oxymeter, snoring sensor, thermistore, limb movement/LM sensors, ECG sensors). The PM was used by installing it to the patient's body for a one-night stay at the hospital. The PM recorded 8 factors for each sensor that will be evaluated.

Correlation between 2 variables was evaluated using the correlation statistic test (Pearson for numeric data and Spearman for category data). (**Table 1**)

Results

From 15 patients who came to the Respiratory Clinic Mitra International Hospital, Jakarta, the age ranged between 16 to 74 year-old with mean 48.93 year-old. There were 14 male patients (93.3%) and 1 female (6.7%).

The Body Mass Index (BMI) ranged between 22.7 to 35.3 and mean was 27.35. There were only 2 patients who had BMI between 18 to 23, while BMI in the other 13 patients were ≥ 23 . (**Table 2**)

Patients were screened with Berlin Questionnaire, where questions are divided into 3 (three) groups and

Table 1. Patient's data

No.	Age	H (m)	W (kg)	BMI	High/Low Risk	AHI	SpO ₂	Lowest SpO ₂	OD	Post-CPAP AHI
1	38	1.71	75	27.4	-/1	2	96.90%	89.00%	4.80%	
2	37	1.72	90	30.3	1/-	72.8	89.10%	89.10%	7.00%	6.45
3	53	1.72	77	26	1/-	38.2	96.50%	81.00%	5.50%	6.8
4	30	1.78	86	26.5	-/1	43	93.90%	77.00%	9.40%	
5	73	1.72	83	28.1	1/-	2.5	96.20%	89.00%	4.50%	
6	51	1.73	96	32.1	1/-	9.6	97.10%	84.00%	5.50%	
7	41	1.6	63	24	1/-	13.4	96.50%	84.00%	5.80%	
8	46	1.78	94	30	1/-	35.8	-	-	-	
9	74	1.62	71	27.1	1/-	13.7	92.60%	81.00%	6.30%	
10	73	1.6	58	22.7	1/-	20.9	90.10%	81.00%	6.20%	
11	37	1.7	69	23.9	-/1	44.7	95.30%	82.00%	5.80%	
12	63	1.68	101	35.8	1/-	19.2	81.60%	68.00%	4.60%	2.5
13	62	1.67	79	28.3	-	15.8	96.80%	80.00%	5.70%	4.88
14 (F)	40	1.68	65	23	-	4.6	95.70%	89.00%	4.40%	
15	16	1.7	74	25.6	-	2.6	98%	87.00%	5.40%	

Table 2. Measurement of body height, body weight and Body Mass Index (BMI)

	N	Minimum	Maximum	Mean	Std. Deviation
Height (cm)	15	1.60	1.78	1.69	0.05
Weight (kg)	15	58.00	101.00	78.73	12.77
BMI	15	22.70	35.30	27.35	3.50

each group contribute to the result mentioning that the patient had high or low risk for obstructive sleep apnea. Unfortunately, the questionnaires from 3 patients were

Oxygen saturation measured by pulse oxymeter (SpO₂) ranged between 81.6% to 98%. Unfortunately, one data was missed. On the average, SpO₂ of our pa-

Table 3. Berlin Questionnaire Categories: Q1 (behavior), Q2 (wake time sleepiness or fatigue), Q3 (obesity or hypertension)

	Q1 (%)	Q2 (%)	Q3 (%)
Negative	1 (8.3)	6 (50)	6 (50)
Positive	11 (91.7)	6 (50)	6 (50)
Total	12 (100)	12 (100)	12 (100)

not found. From the rest 12 patients, 9 patients (75%) had high risk and 3 patients (25%) were low risk for obstructive sleep apnea. (**Table 3**)

Based on AHI, the lowest was 2.00, the highest was 72.8 and the mean was 22.58. There were 4 patients with AHI ≤ 5, while 3 patients with mild OSA (AHI 5-15), 3 moderate OSA (15-30) and 5 with severe OSA (AHI >30). It was a significant correlation between Berlin Questionnaire and AHI (r=0.88, p<0.001). (**Table 4**)

Table 4. Classification of OSA based on AHI

	Frequency	%
No OSA (AHI <5)	4	26.67
Mild OSA (AHI 5-15)	3	20.00
Moderate OSA (AHI 15-30)	3	20.00
Severe OSA (AHI >30)	5	33.33
Total	15	100

tient was 94.02%. The lowest SpO₂ recorded during the test was ranged between 68.0% to 89.1% and the mean for this was 82.93%. Oxygen desaturation (OD) during sleep ranged between 4.40% to 9.40% and the mean was 5.77%. There was strong relation between OD and AHI (r =0.615, p =0.019). (Table 5)

sia. It is estimated that changing in eating habit contributes much; even there is no exact number of prevalence known on this. In this study, we found that in 13 patients the BMI was ≥23 and only 2 patients (13.3%) with BMI 18-23. The BMI was categorized into 3: ≤18 (underweight), 18-23 (normoweight) and >23 (over-

Table 5. Results of AHI and SpO₂ Measured by PM

	AHI	SpO ₂	Lowest SpO ₂	Mean OD	post-CPAP AHI
Number of subject	15	14	14	14	4
Mean	22.59	94.02	82.94	5.78	5.6
Std. Deviation	20.33	4.46	5.86	1.28	1.96

Only 4 patients (2 moderate OSA, 2 severe OSA) can be followed of using continuous positive airway pressure (CPAP) machine after the test. Those patients showed improvement in their AHI. In severe OSA, AHI was improved to 5-15, while in moderate OSA, AHI was improved to <5.

Discussion

Obstructive Sleep Apnea (OSA) was estimated to occur in 1 to 5% of middle-aged men [1]. In Indonesia, we do not know yet the prevalence of OSA for many reasons. Obesity is just growing as a health problem, alcohol use is not high compare to other country where OSA found in high prevalence. It is quite strange and embracing for people (and their couples) to visit a doctor with complain of snoring. Sleepiness is rare correlated with suspicion of OSA and even, not too many doctors or health services concern on cardiovascular diseases (myocardial infarction or stroke) as problem related to obstructive sleep apnea. Attention to sleep disordered breathing in Indonesia was just begun and it is especially in big cities. From all subject, 1 patient was a US citizen (no. 12), 1 female (no. 14) and 1 was a young adult, 16 year-old (no. 15). In patient no. 12, there was a history of alcohol and post cardiac problem. For the last patient, because the age was quite young and the result was quite good (AHI <5, SpO₂ 98%), was sent to a Respiratory Referral Hospital for a retest with a complete polysomnography test in a sleep laboratory, and the result was really the same as previously.

Obesity is strong risk factors. An increase of 1 kg/m² in BMI estimated 30% increase in the odds of developing OSA and 9% increase in the AHI [1]. Nowadays, obesity is growing as health problem in Indone-

sia. Even 4 of our patients had their BMI of >30. It means that almost all patients were overweight (86.7%). Unfortunately there were no description of fat deposition of the patient, since neck circumference has been shown as strong predictor of OSAHS (<37 cm-low risk, >48 cm-high risk) [9].

Although many studies indicating that alcohol is also one potential factor, the effects is still unknown (1). Only patient no. 12 mentioned that he has the history of using alcohol before he got the heart attack.

Craniofacial morphology is indicated as the risk factors. Enlarged tonsils and adenoid during childhood may predispose to OSA in adulthood [1,9], along with retrognathia, micrognathia as well [9]; however, the contribution still only account for small number in OSA's prevalence [1]. White [4] said that it is still unclear whether defining craniofacial abnormalities would have therapeutic implication or not. We did not find that history on those patients.

Around 35-45% of men and 15-28% of women report habitual snoring [9] especially in adults over the age of 50 year-old [14], and only 6% of patients with OSAHS do not report snoring [9]. A retrospective analysis of 250 subjects found that snoring was strongly associated with the presence of OSA even the positive predictive value (PPV) and negative predictive value (NPV) were only 0.63 and 0.56 [14]. All subjects in this study came to our Respiratory Clinic with chief complaint of snoring. Snoring is an important factor since habitual loud snoring and frequent breathing pauses were 3-4 times more likely to have an apnea/hypopnea index (AHI) of >15 [9].

A simple way to determine risk factor for having sleep apnea is by taking sleep history. The patients were asked to report their symptoms. The Berlin Questionnaire asks about risk factors for sleep apnea, namely snoring be-

havior, wake time sleepiness or fatigue and the presence of obesity or hypertension [16]. The category high or low risk for sleep apnea based on responses in three symptom categories:

- 1: high risk- persistent symptoms (>3 times/week) in ≥ 2 questions about snoring
- 2: high risk- persistent (>3 times/week) wake time sleepiness, drowsy driving, or both
- 3: high risk- history of high blood pressure or a BMI >30

If the patient fit for at least 2 symptom categories, he/she will be considered at high risk for sleep apnea.

In this study, unfortunately, 3 patients were not assessed by this questionnaire. From the rest 12 patients, we found that 9 (75%) patients were at high risk for having sleep apnea.

Apnea/Hypopnea Index (AHI) is an important factor to be counted on sleep study. Patient with an AHI of >40 recorded in the first 2 hours of polysomnography (PSG) should directly consider as OSAHS without proceeding to a full night study [9]. A significant correlation was found between AHI and Berlin Questionnaire ($r=0.88$, $p<0.001$) that may means that without PSG, Berlin Questionnaire can be used to screen high-risk patient and it was confirmed by using Type 3-PM in an attended facility setting.

The use of CPAP also showed that there was improvement in AHI. In moderate OSA, AHI turned to <5 while in severe OSA to 5-15. It is similar to most studies showing that CPAP significantly reduce sleep related respiratory events compared to control [13].

The advantages of Portable Monitoring (PM) are requires less technical expertise, less recording labor intensive and time consuming, and easier for patient to access [17]. There are 4 types of sleep-study monitoring devices [17]. Type 1 is standard, in-laboratory, technician attended, overnight polysomnography. The other 3 types are PM devices: Type 2- comprehensive portable polysomnography; Type 3-modified portable sleep apnea testing, and Type 4-continuous single or dual bioparameter. Although various studies also found limitations in some PM but in attended setting, this device is reliable and feasible in limited facilities and more easy to set up as well [18]. The PM used in this study was a Type 3 PM. One patient (no. 8) was disconnected with pulse oxymeter, that we cannot get the result of oxygen saturation (SpO_2). The patient itself knew and realized that he suffers restless sleep. Type 3 PM, also referred to as cardiorespiratory sleep study, may increase or decrease the probability that a patient has an AHI >15 when used in an attended setting [14].

With the exception of one data missed, the oxygen saturation ranged between 81.6% to 98%. For 4 patients with AHI <5, the lowest SpO_2 was 95.7%. In 3 patients with AHI 5-15, the lowest SpO_2 was 92.6%. In 3 patients with AHI 15-30, the lowest SpO_2 was 81.6% and for the last 5 patients with AHI >30, the lowest SpO_2 was 89.1%. It can be clearly seen that in patients with moderate to severe OSA, the SpO_2 was also low and even below 90%. Fietze *et al* [12] in their study reported that the median oxygen saturation was 96.2%, while Gries and Brooks [15] reported that in their study found the mean $SD \pm$ Low Sat was $90.4\% \pm 3.1\%$.

In this study, we can see that on the individual base, the lowest SpO_2 during the test was ranged between 68% (shown by patient no. 12) to 89.1% (patient no. 2). Patient no. 12 is a US citizen of 63 year-old with the history of cardiac disease (MCI and pulmonary edema) 3 years ago and still under treatment. Previously he drank alcohol a lot and smoked sometimes. Both habits have already stopped after the cardiac attack. At the time for the study, the BMI was 35.8, AHI 19.2, high-risk and SpO_2 81.6%. Patient no. 2 was 37 year-old with BMI 30.3, AHI 72.8, high-risk and SpO_2 89.1%. In patient no. 3, 53 year-old with BMI 26, AHI 38.2, high-risk and SpO_2 96.5%, the lowest SpO_2 was 81%. Patient no. 13, a man of 62 year old, BMI 28.3, AHI 15.8, SpO_2 96.8% and the lowest SpO_2 was 80%. All those 3 patients and patient no. 3 luckily could be followed in using CPAP. The result of using CPAP in these patients was good. The AHI improvement in patient no. 2 was from 72.8 (pre CPAP) to 6.45 (post CPAP). Patient no. 3: 38.2 to 6.8; patient no. 12: 19.2 to 2.5, and patient no. 13: 15.8 to 4.88 respectively. Follow up should be done on these patients.

In conclusion, the study above indicating that Berlin Questionnaire is quite reliable in obtaining data for the risk of sleep apnea, as the Type 3 PM we used in attended setting was also quite reliable and valid in determining parameters related to BMI and AHI. We realized it should be more subjects join the study, and even the study itself can give more meanings if all subject using CPAP and well followed. As a preliminary, this study also gave the opportunity to patient who difficult to get access to a Sleep Laboratory, and also the chance for diagnosing sleep apnea hypopnea syndrome in nonsophisticated health facility.

Acknowledgment

I thank Dr. Ida Bernida for assisting me in this study, Ms. Lin Gustina for processing data in computerized base, Dr. Wahyu Aniwidyarningsih and Dr. Rita Rogayah for supervising the manuscript, and Dr. Ninuk (Director of the Hospital).

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