Original contribution

Preoperative identification of sleep apnea risk in elective surgical patients, using the Berlin questionnaire☆

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Abstract

Study Objective: To examine the prevalence of risk of sleep apnea in patients undergoing elective surgery by using the Berlin Questionnaire.
Design: Survey instrument.
Settings: Preoperative assessment clinic.
Patients: 305 surgical ASA physical status I, II, III, and IV patients.
Interventions: Patients were screened with the Berlin questionnaire for obstructive sleep apnea. For patients deemed at high risk of sleep apnea by the Berlin questionnaire, a letter was sent to their family physician requesting referral of patient to have an overnight polysomnography test for the diagnosis of obstructive sleep apnea.
Measurements: The number of patients identified by the Berlin questionnaire as being at high risk of obstructive sleep apnea was identified. The number of patients with a history of obstructive sleep apnea and those newly confirmed by polysomnography were also identified.
Main Results: The Berlin questionnaire identified 24% (73/305) of patients as being at high risk of sleep apnea (95% confidence interval, 19%-29%). Thirteen patients were confirmed to have obstructive sleep apnea, resulting in a frequency of 4.2%; 9 patients had a history of obstructive sleep apnea, and 5 patients were identified by polysomnography.
Conclusions: The Berlin questionnaire correctly identified all patients previously diagnosed with sleep apnea as being at high risk.
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1. Introduction

Sleep apnea is a disorder associated with increased risk of morbidity and mortality. Gupta and colleagues [1] have shown that persons with sleep apnea are more than twice as likely to undergo serious respiratory or cardiac adverse events

after orthopedic joint replacement. This increased likelihood of adverse events may be related to the exquisite sensitivity of subjects with sleep apnea to opioid analgesic agents [2,3]. Incidents of unexplained cardiopulmonary arrest after general anesthesia have been reported in association with sleep apnea [2], and have been linked to opioid administration [3]. Sleep apnea is also linked to difficult airway management and difficult intubation [4,5]. Identification of sleep apnea before surgery allows the risk to be minimized by formulating a difficult airway/intubation plan, an appropriate anesthetic technique, and postoperative monitoring.

The "gold standard" for diagnosis of sleep apnea is an overnight sleep study (polysomnography). However, such testing is expensive, time-consuming, and clearly unsuitable for screening purposes. Questionnaire-based screening tools have been developed to identify the symptoms of sleep apnea [6-9].

The literature indicates that the most widely used screening tool for detecting sleep apnea is the Berlin questionnaire. One study has assessed the validity of the Berlin questionnaire in identifying sleep apnea risk in the primary care setting [9]. Among US primary care (nonsurgical) patients, the Berlin questionnaire identified 37.5% of patients as being at high risk, demonstrating a sensitivity and specificity of 0.86 and 0.77, respectively, in identifying patients with more than 5 respiratory events per hour [9,10]. The questionnaire consists of 9 items regarding snoring, witnessed apneic events, daytime sleepiness, and falling asleep while driving (Appendix). The purpose of this study was to use the Berlin questionnaire to identify the percentage of elective surgical patients at high risk of sleep apnea.

2. Materials and methods

Toronto Western Hospital ethics board approval was obtained before patients were recruited. A calculation of sample size requirement was made based on the finding of Harrison and colleagues [11] of a sleep apnea prevalence of 6.7% among elective orthopedic patients. To assess the prevalence with an accuracy of $\pm3\%$ (95% confidence level), a sample size of 267 was calculated. Recruitment to the study continued until 305 patients were enrolled in the study. Patients were recruited during their preoperative assessment visit to the hospital. Patients were scheduled for elective procedures in general surgery, orthopedics, urology, plastic surgery, ophthalmology, or neurosurgery. Patients undergoing surgery requiring monitored anesthesia with sedation only, or local anesthesia, were excluded from the study. Following informed consent, patients were asked to complete the Berlin questionnaire. Physical data regarding blood pressure and body mass index (BMI) were also recorded. Patients were stratified into high-risk or low-risk groups for sleep apnea based on their responses in three symptom categories, based on the work of Netzer and

colleagues [9] (*see Appendix for details of questions by category*). The Berlin questionnaire defines high risk as the following:

In category 1, high risk is defined as persistent symptoms (>three to 4 times per week) in two or more questions about their snoring.

In category 2, high risk is defined as persistent (>three to 4 times per week) wake time sleepiness, drowsy driving, or both.

In category 3, high risk is defined as a history of high blood pressure or a BMI more than 30 kg/m^2.

To be considered at high risk for sleep apnea, a patient has to qualify for at least two symptom categories. Those who deny having persistent symptoms or who qualify for only one symptom category are placed in the lower risk group.

The charts of high-risk patients were clearly marked as such before the patients' preassessment interview with an anesthesiologist.

A retrospective chart analysis was carried out on all 305 patients. Adverse intraoperative and postoperative outcomes were identified. The high-risk and low-risk groups for sleep apnea as identified by the Berlin questionnaire were compared. For patients deemed at high risk of sleep apnea by the Berlin questionnaire, a letter was sent to their family physician requesting referral for overnight polysomnography testing for diagnosis of sleep apnea at the Toronto Western Hospital sleep laboratory. Continuous data were compared using the Student's t test. Noncontinuous data were compared using the χ^2 test.

3. Results

The Berlin questionnaire identified 24% (73/305) of all patients as being at high risk of sleep apnea (Table 1) (95% confidence interval, 19%-29%). Nine patients in the study had been diagnosed previously with sleep apnea. The Berlin

Table 1   Berlin questionnaire results

	Sample overall	Berlin high-risk group	Berlin low-risk group
No. of patients, n (%)	305	73 (24)	232 (76)
Gender (% male)	53.5	56.6	52.5
Age (y)	54 (16)	58 (14)*	53 (16)
BMI	28 (5)	32 (4)*	26 (4)
Hypertension, n (%) (overt or treated)	116 (36.5)	67 (58)*	49 (21)
Prior diagnosis of sleep apnea, n (%)	10 (3.1)	10 (13.2)	0 (0)

Values are means (SD) unless otherwise specified. BMI = body mass index.

  * $P < 0.01$, significant difference between high-risk and low-risk groups.

Table 2 Adverse events by risk group

	High-risk group	Low-risk group
Mortality, n (%)	1 (1.4)	0 (0)
Hospital stay (d)	2.4 (3.0)	2.5 (3.5)
PACU stay (min)	107 (72)	91 (52)
Readmission within 30 d, n (%)	0 (0)	1 (0.4)
Unplanned ICU admission, n (%)	0 (0)	0 (0)
Difficult intubation,[a] n (%)	4 (6.6)	18 (8.4)
PACU adverse events, n (%)		
Cardiac	1 (1.4)	10 (4.2)
Respiratory	6 (9.2)	22 (8.7)
Neurologic	1 (1.4)	1 (0.4)
Uncontrolled pain	6 (8.7)**	1 (0.4)
Postoperative adverse events, n (%)		
Cardiac	2 (2.9)	15 (6.3)
Respiratory	11 (15.9)	33 (13.8)
Neurologic	0 (0)	1 (0.4)

Values are means (SD) unless otherwise specified. PACU = Post-anesthesia care unit; ICU = intensive care unit.

 [a] As reported by anesthesiologist (Cormack-Lehane grade III or above).

   ** $P = 0.001$.

questionnaire correctly identified all these patients as being at high risk.

For 73 patients deemed to be at high risk of sleep apnea, their family physician was requested to refer them for polysomnography testing. Only 6 patients (of the 73) were referred. Of the 6 patients tested, three were diagnosed with severe sleep apnea, one was diagnosed with mild sleep apnea, and two were not found to exhibit features of sleep apnea on polysomnography. With the 9 previously diagnosed patients with obstructive sleep apnea and 4 newly diagnosed patients with obstructive sleep apnea, 13 patients were confirmed to have obstructive sleep apnea in 305 patients. This finding implies a minimal frequency of 4.2% of surgical patients having obstructive sleep apnea in our preadmission clinic.

Patients identified by Berlin questionnaire to be in the high-risk group were significantly older than those in the low-risk group (Table 1). Their BMI was significantly higher and they had a higher frequency of hypertension.

Charts were reviewed retrospectively for perioperative adverse events. Two hundred ninety-six patient charts were reviewed with 9 charts missing. These represent 224 (97%) of 232 low-risk patients and 72 (99%) of 73 high-risk patients. Analysis of perioperative adverse events did not show any significant cardiac, respiratory, or neurologic morbidity in the high-risk group versus the low-risk group (Table 2). The only mortality was in the high-risk group. One patient died of postoperative myocardial infarction and respiratory failure.

There was no significant difference between the two groups in overall hospital length of stay, unplanned ICU admission rates, or 30-day readmission rates. Patients in the high-risk group spent significantly longer in the post-anesthesia care unit (PACU); (110 vs 91 minutes, $P < 0.05$) and had a significantly higher frequency of uncontrolled pain in the PACU (9.1% versus 0.4%, $P < 0.01$) than did low-risk patients. No significant difference was noted in the difficulty of intubation of the high-risk group versus the low-risk group (difficult intubation determined as Cormack-Lehane grade III or greater, as rated by the attending anesthesiologist).

4. Discussion

In our study, 24% of elective surgical patients were identified as being at high risk of sleep apnea. This figure represented the number of patients at high risk of sleep apnea as identified by the Berlin questionnaire. The exact diagnosis of sleep apnea has to be confirmed by polysomnography. Prevalences as high as 24% have been reported among men in certain communities using sleep studies [12]. A large population-based study reported that based on an Apnea Hypoxia Index (AHI) score of 10 or higher, obstructive sleep apnea affects approximately 12% of men and 5% of women aged between 30 and 60 years [11]. Four major studies of the prevalence of obstructive sleep apnea using polysomnography showed that the estimated prevalence of severe obstructive sleep apnea, defined as an AHI score greater than 15, is 7% to 14% in men and 2% to 7% in women [12-15]. If mild disease is considered (AHI >5 events per hr), the prevalence is 17% to 26% in men and 9% to 28% in women. The prevalence of sleep apnea in patients presenting for elective joint arthroplasty was 6.7% [11]. The variable results reported in the literature indicate more studies need to be done in this area.

The Berlin questionnaire was designed for use in a primary care population of patients. High-risk prevalences of 37.5% (USA, 744 subjects) [9], 35.8% (USA, 3915 subjects) [16], and 26.3% (Europe, 2308 subjects) [16] have been reported. When sleep studies have been carried out on sample groups, the questionnaire has demonstrated a sensitivity of 0.86 and specificity of 0.77 for identifying patients with more than 5 respiratory events per hour. It has a positive predictive value of 0.89 and a likelihood ratio of 3.79. For detecting patients with more than 15 respiratory events per hour, the sensitivity and specificity were 0.54 and 0.97, respectively [9]. A questionnaire-based screening may have overdiagnosed mild to moderate sleep apnea. Six patients were referred for polysomnography, and 4 patients who were rated as high risk demonstrated more than 15 respiratory disturbances per hour when formally tested with a sleep study. These figures suggest that when the Berlin questionnaire is used for preoperative screening, a positive result should warrant further direct questioning and clinical examination regarding sleep apnea. It should be remembered that underdiagnosis of sleep apnea is likely to be common—one study estimated that 93% of women and 82% of men with moderate to severe sleep apnea had not been clinically diagnosed [17].

The large discrepancies in the prevalence of sleep apnea in the literature may have many interpretations. The estimation of prevalence can be affected by the measurement approaches and can also vary by different study populations. In our study, we used the screening method of Berlin questionnaire, and the study population included patients who were being assessed for an array of surgical procedures. From the data, we have gathered that it is not possible to conclude whether the Berlin questionnaire overestimated the prevalence of sleep apnea. The rate is severalfold higher than the surgical population studied by Harrison et al [11] but is in keeping with the detection rates in other studies [12-16]. In addition, it is possible that the surgical population we studied had a high risk of obstructive sleep apnea due to the higher mean BMI (28 kg/m^2). Our center also had a higher incidence of Asians, which may be a contributing factor [18].

Although the Berlin questionnaire stratified a slightly larger proportion of men than women into the high-risk group, the proportions were not significantly different from the 55%/45% division seen in the sample as a whole. In sleep clinic populations, sleep apnea is a condition largely affecting men. Men-women ratios of between 10:1 and 90:1 are quoted [19]. In the community, however, men-women ratios of 2:1 have been reported [20]. Our results may reflect underdiagnosis of the condition in women. Our results indicated that patients who were identified to be at higher risk of obstructive sleep apnea were significantly older, more obese, and had a higher frequency of hypertension. This finding is consistent with the literature [21-24].

Sleep apnea is linked with difficult airway management, difficult intubation [4,5], and increased perioperative adverse events [1,2]. Our results showed that patients who screened positive by the Berlin questionnaire did not have a higher frequency of difficult airway management and perioperative adverse events. However, patients determined to be at high risk of sleep apnea spent significantly longer in the PACU and had significantly higher rates of uncontrolled pain than did low-risk patients. This finding may be explained by a reluctance on the part of the anesthesiologists to use opioid analgesia in patients thought to be at high risk of sleep apnea. The anesthesiologists responsible for the patient was aware of the Berlin risk result, and this may well have influenced the amount of intraoperative opioid analgesia given. This conjecture warrants further systematic study.

An important limitation of this study is that it was not possible to compare the results of the Berlin questionnaire with a definitive polysomnographic diagnosis. It is thus not possible to calculate sensitivity, specificity, or positive/ negative predictive values. The turnout rate of less than 8% underlines the difficulties faced in validating tests for sleep apnea in a surgical population.

The ASA recently published a guideline on perioperative management of obstructive sleep apnea [25]. It recommends that anesthesiologists and surgeons preoperatively screen patients for possible obstructive sleep apnea [25]. Therefore, this study highlights the importance of eliciting this information preoperatively.

In conclusion, 24% of elective surgical patients may be at high risk of obstructive sleep apnea. The confirmed incidence of obstructive sleep apnea is 4.2% in this surgical population. This incidence may be higher if the high-risk patients identified by the Berlin questionnaire were all referred to polysomnography. Further study is required to determine which proportion of patients identified as being at high risk have clinically significant sleep apnea. Postoperative pain may be linked to obstructive apnea risk.

Appendix A. The Berlin Questionnaire

Category 1
Do you snore?
Yes/No/Don't know
Snoring loudness?
Loud as breathing/Loud as speaking/Louder than speaking / Very loud (can be heard in adjacent rooms)
Snoring frequency?
Almost every day/3 to 4 times per week/1 to 2 times per week/1 to 2 times per month/Never or almost never
Does your snoring bother other people?
Yes/No
Has anyone noticed that you quit breathing during sleep?
Almost every day/3 to 4 times per week/1 to 2 times per week/1 to 2 times per month/Never or almost never
Category 2
How often do you feel tired or fatigued after sleeping?
Almost every day/3 to 4 times per week/1 to 2 times per week/1 to 2 times per month/Never or almost never
Are you tired during wake time?
Almost every day/3 to 4 times per week/1 to 2 times per week/1 to 2 times per month/Never or almost never
Have you ever fallen asleep while driving?
Yes/No (If yes, how often?)
Category 3
Do you have high blood pressure?
Yes/No/Don't know
What is your weight?
What is your height?
Significant symptoms = Answering "Almost every day" or "3 to 4 times per week" in 2 or more questions in category 1 or 2. In category 3, significant symptoms are hypertension or BMI >30 kg/m^2.

High risk = significant symptoms in 2 out of 3 categories.

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