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Using the Berlin Questionnaire To Identify Patients at Risk for the Sleep Apnea Syndrome

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Background: Although sleep apnea is common, it often goes undiagnosed in primary care encounters.

Objective: To test the Berlin Questionnaire as a means of identifying patients with sleep apnea.

Design: Survey followed by portable, unattended sleep studies in a subset of patients.

Setting: Five primary care sites in Cleveland, Ohio.

Patients: 744 adults (of 1008 surveyed [74%]), of whom 100 underwent sleep studies.

Measurements: Survey items addressed the presence and frequency of snoring behavior, waketime sleepiness or fatigue, and history of obesity or hypertension. Patients with persistent and frequent symptoms in any two of these three domains were considered to be at high risk for sleep apnea. Portable sleep monitoring was conducted to measure the number of respiratory events per hour in bed (respiratory disturbance index [RDI]).

Results: Questions about symptoms demonstrated internal consistency (Cronbach correlations, 0.86 to 0.92). Of the 744 respondents, 279 (37.5%) were in a high-risk group that was defined a priori. For the 100 patients who underwent sleep studies, risk grouping was useful in prediction of the RDI. For example, being in the high-risk group predicted an RDI greater than 5 with a sensitivity of 0.86, a specificity of 0.77, a positive predictive value of 0.89, and a likelihood ratio of 3.79.

Conclusion: The Berlin Questionnaire provides a means of identifying patients who are likely to have sleep apnea.

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The obstructive sleep apnea–hypopnea syndrome is a potentially disabling condition characterized by excessive daytime sleepiness, disruptive snoring, repeated episodes of upper airway obstruction during sleep, and nocturnal hypoxemia. Epidemiologic surveys indicate associations among snoring, sleep apnea, and cardiovascular disease (1). A 1993 population-based study (2) of workers in Wisconsin found that 2% of women and 4% of men had symptoms of sleepiness with associated levels of sleep apnea believed to indicate at least a moderate degree of illness. Prevalence estimates from other countries and other U.S. studies are similar (3–5). Recognition of sleep apnea by community physicians is, however, low. In the Wisconsin study (6), only 7% of women and 12% of men who had moderate to severe illness reported receiving a diagnosis of sleep apnea from a medical encounter.

Two studies observed that specialist intervention with diagnostic equipment (7) or intensive physician education on taking a sleep history (8) improved recognition of sleep apnea in primary care practices. However, both approaches required substantial professional and technical resources. Asking patients to report their symptoms is a simple alternate approach that has been shown to be helpful in sleep referral clinics and community surveys (1).

The Berlin Questionnaire asks about risk factors for sleep apnea, namely snoring behavior, waketime sleepiness or fatigue, and the presence of obesity or hypertension. We evaluated the usefulness of this instrument in identifying patients with sleep apnea in primary care settings.

See editorial comment on pp 535-536.

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Methods

The Berlin Questionnaire

The Berlin Questionnaire was an outcome of the Conference on Sleep in Primary Care, which involved 120 U.S. and German pulmonary and primary care physicians and was held in April 1996 in Berlin, Germany. Questions were selected from the literature to elicit factors or behaviors that, across studies, consistently predicted the presence of sleep-disordered breathing (1, 9–15). By consensus, the instrument focused on a limited set of known risk factors for sleep apnea. One introductory question and four follow-up questions concern snoring; three questions address daytime sleepiness, with a subquestion about sleepiness behind the wheel (that is, while driving a motor vehicle). One question concerns history of high blood pressure. Patients are also asked to provide information on age, weight, height, sex, neck circumference, and ethnicity. Obesity was quantified by calculating body mass index from self-reported weight and height. The responses to these questions have utility in non–primary care settings (1).

The conference also proposed a plan for risk grouping to simplify recognition of sleep apnea; this strategy was shown to be useful in sleep clinic and community surveys (11, 13, 15). Predetermination of high risk and lower risk for sleep apnea was based on responses in three symptom categories. In category 1, high risk was defined as persistent symptoms (>3 to 4 times/wk) in two or more questions about their snoring. In category 2, high risk was defined as persistent (>3 to 4 times/wk) waketime sleepiness, drowsy driving, or both. In category 3, high risk was defined as a history of high blood pressure or a body mass index more than 30 kg/m^2. To be considered at high risk for sleep apnea, a patient had to qualify for at least two symptom categories. Those who denied having persistent symptoms or who qualified for only one symptom category were placed in the lower risk group.

Survey Distribution

One thousand questionnaires in batches of 200 per study site were provided to individual physicians at five sites in the Cleveland, Ohio, area. The sites were chosen on the basis of geographic and socioeconomic diversity (further information is available from the authors on request). Three physicians were solo practitioners and 2 were members of a practice group; all practices were part of a hospital-owned network that at the time of study included 92 primary care physicians who cared for adults. All 5 participating physicians were Board-certified in internal medicine, and 2 had more advanced training (rheumatology or pulmonary medicine). By design, all participating physicians had practiced primary care medicine for more than 4 years and had stable practice patterns, each handling a panel of 2500 to 3000 patients. According to network records, no physician had referred more than 2 patients for sleep studies in the previous year.

Office staff handed out questionnaires to consecutive patients who visited the study physician for any reason. Each site was instructed to return the questionnaires to the sleep center. Completed questionnaires were included in our analysis if they met the following criteria: They had to be dated, the date had to fall within 3 weeks of distribution, and they had to be returned to the sleep center within 1 month. The study was approved by the institutional review board of University Hospitals of Cleveland.

Sleep Studies

Portable monitoring of respiratory disturbances during sleep was offered to both high-risk and lower-risk patients. The intent was to study approximately 20% of respondents, equally distributed in both risk groups. From an alphabetically ordered list, the first 75 patients in the high-risk group and the first 65 patients in the lower-risk group were contacted by telephone and asked to participate. Patients who agreed to sleep studies were visited at home, instructed on the use of the monitor, and monitored overnight; the monitor was retrieved the next day. Patients gave written consent for portable monitoring and for results to be sent to their primary care physician.

Monitoring was performed with a six-variable, four-channel Eden Tec recorder (Nellcor Puritan Bennett, Minneapolis, Minnesota). Variables measured included nasal and oral airflow by thermistor, chest wall movement by impedance electrodes, and oxygen saturation (SaO_2) and pulse rate by pulse oximeter. A respiratory disturbance event was defined as a decrease in nasal or oral airflow, alone or with chest wall movement of approximately 50% that lasted for 10 seconds or more. A decrease in SaO_2 of 4% or more was considered significant oxygen desaturation. The recorder was taken to the patient's home, where he or she was instructed on how to use the recording device and to turn it on at bedtime and to turn it off upon arising (13). Measurements from a full-disclosure printout were manually scored for a respiratory disturbance index (RDI) (measured as the number of respiratory events per hour in bed) and the oxygen desaturation index (number of decreases in SaO_2 of $\geq$ 4% per hour in bed). Acceptable records were those in which the patients spent at least 6 hours in bed and good to excellent recording of SaO_2 and respiration (either impedance or thermistor records or both)

was achieved (13). A single researcher who had no knowledge of the questionnaire results performed the scoring.

Statistical Analysis

The quantitative distribution of returned questionnaires, individual patient variables, responses to individual questions about sleep-related symptoms, and results of home sleep monitoring are expressed by descriptive statistics (frequencies, mean ± SD, and range). Missing data and data that are not applicable are expressed in the percentage of the returned questionnaires and in total number of patients for each variable. Answers to questions on sex and study site were evaluated by using the chi-square test and were expressed by the significance level. The Pearson correlation test and level of significance were used to compare questionnaire responses and risk groupings. We used a logistic regression model that examined the relative effects of age, sex, and the three symptom categories and risk group. The predictive accuracy (16) of risk grouping and of each category was assessed for RDIs of 5 or less, more than 5, more than 15, and more than 30; these arbitrary cut-off values are similar to those used in previous studies (2, 6) and those proposed as diagnostic criteria (17). Computations were performed by using SPSS 7.5 for Windows (SPSS, Inc., Chicago, Illinois).

Table 1. Self-Reported Characteristics of the 744 Survey Respondents*

Characteristic	Data
Mean age ± SD, *y*	48.9 ± 17.5
Sex, *n (%)*	
Male	310 (41.7)
Female	403 (54.2)
Not reported	31 (4.2)
Body mass index, *n (%)*	
<30 kg/m²	370 (49.7)
≥30 kg/m²	276 (37.1)
Not reported	98 (13.2)
Mean body mass index ± SD, *kg/m²*	29 ± 7.2
High blood pressure, *n (%)*	
Yes	194 (26.1)
No	460 (64.7)
Do not know	57 (7.7)
Not reported	33 (4.4)
Mean neck circumference ± SD, *cm*†	39 ± 4.4

* Because 632 (84.4%) of the 744 respondents did not provide information about their ethnicity, this information was excluded from analysis.
† Because 321 (43%) of the 744 respondents did not provide information about neck circumference, this information was excluded from analysis.

Results

Of 1008 questionnaires (one physician had distributed an additional 8 questionnaires), 744 (74%) were entered for analysis. The variability in return rate resulted from time constraints and unavailability of staff rather than patient refusal. The return rate did not correlate with the socioeconomic profile of the practice site; solo practices had greater response rates. One male respondent and one female respondent reported that they had received a diagnosis of or treatment for sleep apnea; their results were included in the analysis.

Characteristics of the respondents are shown in **Table 1**. Because responses to the questions on neck circumference and ethnicity were often not provided, these results were not included in the analyses.

Prevalence of Symptoms

Of the 744 respondents, 388 (52.2%) reported that they snored, 223 (30.0%) denied snoring, 118 (15.9%) did not know whether they snored, and 15 (2%) did not respond to this question. Ninety-four of all respondents (24.6%) reported that their snoring was louder than normal speech and 289 (75.4%) did not snore louder than normal speech. Two hundred three (47.9%) respondents reported snoring at least three to four times per week, and 221 (52.1%) said that they did not snore more than one to two times per week. Two hundred seventy-four (54.9%) respondents reported that their snoring bothered other people, whereas 225 (45.1%) denied that it did. In 66 (11.1%) respondents, breathing pauses during sleep were observed by others at least 1 to 2 times per month; in 31 (5.2%) respondents, breathing pauses were observed more than 3 to 4 times per week. Two hundred forty-three (33.8%) respondents stated that they did not feel rested after a night's sleep at least 3 to 4 times per week; 476 (66.2%) felt this way less often or not at all. Two hundred seventy-nine (38.8%) respondents said that they experienced waketime tiredness or fatigue at least 3 to 4 times per week; 441 (61.2%) experienced this problem one to two times per week or less often.

Of 721 (96.9% of the sample) respondents to the question about drowsiness behind the wheel, 137 (19.0%) said that they had nodded off or fallen asleep while driving. Fifteen respondents (4.4%) reported that they nodded off at the wheel at least three to four times per week. **Table 2** shows the numbers of patients with these characteristics in each risk group.

Internal Validity

The reliability among individual questions within symptom categories was examined as a measure of internal validity. The Cronbach α value was 0.92 for correlation of questions within category 1 and 0.63 for category 2. When the question about sleepiness behind the wheel was excluded, the Cronbach α value in category 2 increased to 0.86.

Table 2. Distribution of Responses by Risk Group

Question	High-Risk Patients	Lower-Risk Patients	*P* Value
	n (%)		
Has your weight changed?			
Increased	175 (63.4)	231 (51.6)	
Decreased	45 (16.3)	86 (19.2)	0.006
No change	56 (20.3)	131 (29.2)	
Do you snore?			
Yes	238 (85.9)	150 (33.2)	<0.001
No	20 (7.2)	203 (44.9)	
Do not know	19 (6.9)	99 (21.9)	
Snoring loudness			
Loud as breathing	78 (33.9)	91 (59.5)	
Loud as talking	72 (31.3)	48 (31.4)	<0.001
Louder than talking	39 (17.0)	8 (5.2)	
Very loud	41 (17.8)	6 (3.9)	
Snoring frequency			
Almost every day	110 (48.7)	27 (13.6)	
3–4 times/wk	49 (21.7)	17 (30.8)	<0.001
1–2 times/wk	39 (17.3)	57 (28.8)	
1–2 times/mo	13 (5.8)	34 (17.2)	
Never or almost never	15 (6.6)	63 (31.8)	
Does your snoring bother other people?			
Yes	194 (75.5)	80 (33.1)	<0.001
No	63 (24.5)	162 (66.9)	
How often have your breathing pauses been noticed?			
Almost every day	18 (7.6)	0 (0.0)	
3–4 times/wk	12 (5.1)	1 (0.3)	<0.001
1–2 times/wk	8 (3.4)	5 (1.4)	
1–2 times/mo	9 (3.8)	13 (3.6)	
Never or almost never	190 (80.2)	339 (94.7)	
Are you tired after sleeping?			
Almost every day	110 (40.1)	40 (9.0)	
3–4 times/wk	50 (18.2)	43 (9.7)	
1–2 times/wk	46 (16.8)	128 (28.8)	<0.001
1–2 times/mo	29 (10.6)	85 (19.1)	
Never or almost never	39 (14.2)	149 (33.5)	
Are you tired during waketime?			
Almost every day	107 (38.6)	52 (11.7)	
3–4 times/wk	67 (24.2)	53 (12.0)	<0.001
1–2 times/wk	43 (15.5)	139 (31.4)	
1–2 times/mo	36 (13.0)	106 (23.9)	
Never or almost never	24 (8.7)	93 (21.0)	
Have you ever fallen asleep while driving?			
Yes	78 (28.4)	59 (13.2)	<0.001
No	197 (71.6)	387 (86.8)	
Do you have high blood pressure?			
Yes	125 (45.8)	69 (15.8)	<0.001
No	129 (47.3)	331 (75.6)	
Do not know	19 (7.0)	38 (8.7)	

Patient Sex and Study Site

Men and women did not differ with respect to age (47.8 ± 16.9 years and 48.8 ± 17.8 years), body mass index (30.3 ± 6.2 kg/m^2 and 29.6 ± 7.6 kg/m^2), or history of high blood pressure (78 men [25.9%] and 109 women [28.2%]). Men were more likely than women to snore, to stop breathing during sleep, and to report drowsy driving, whereas women were more likely than men to feel tired after sleep or during waketime (data not shown).

Sites did not systematically vary for socioeconomic profile, the percentage of respondents who qualified for symptom category 1 or 2, or reports of drowsy driving (**Table 3**). Sites differed significantly for prevalence of respondents with a body mass index more than 30 kg/m^2, hypertension, or both (category 3) and for the number of respondents meeting the criteria for high risk for sleep apnea (data not shown).

The percentage of respondents in the high-risk group by study site ranged from 29% to 45%; this was not accounted for by differences in symptom categories. More men (44.5%) than women (33%) were at high risk ($P < 0.002$). As expected, high-risk patients were more likely to have a higher body mass index, to be male, to have a history of high blood pressure, to have gained weight recently, to snore loudly and have observed apneas, to be tired during waketime, and to fall asleep at the wheel. The latter three behaviors are a core set of symptoms in the definition of sleep apnea (17). A logistic regression model for risk grouping identified a significant ($P < 0.001$) influence of each category without a significant contribution of age or sex.

Sleep Study Results

Recruitment for sleep studies and recording of data was completed for 100 (13.4%) respondents:

69 of 75 in the high-risk group and 31 of 65 in the lower-risk group. Five patients in the high-risk group and 32 in the lower-risk group declined monitoring. In 3 patients (2 at lower risk and 1 at high risk), monitoring resulted in no collected data, and these patients chose not to undergo repeated studies. Patients who underwent sleep studies did not differ significantly for age and sex between risk groups or from the total group of respondents (data not shown).

The **Figure** shows the distribution of the two risk groups with respect to RDI. The mean RDI in the high-risk group was 21.1 ± 18.5 (range, 0 to 101), the mean oxygen desaturation index was 19.4 ± 19.5 (range, 50 to 97), and the mean lowest SaO_2 was 82.6% ± 9.2% (range, 50% to 97%). Mean values in the lower-risk group were 4.7 ± 7.0 (range, 0 to 37) for RDI, 5.9 ± 7.6 (range, 0 to 35) for oxygen desaturation index, and 89.9% ± 5.9% (range, 97% to 71%) for lowest SaO_2.

Table 4 shows the ability of risk grouping to predict patients with elevated RDIs. The proportion of high-risk patients who were in the group that underwent monitoring was higher than that seen among all respondents. Nevertheless, if a patient qualifies for fewer than two risk categories—that is, if he or she is at lower risk—the likelihood that the patient has an RDI of 5 or less is strong; the corresponding post-test probability for this test result is approximately 70% (16). In contrast, high-risk patients were more likely to have an RDI of more than 5 and hence meet criteria for the obstructive sleep apnea–hypopnea syndrome (16). As the diagnostic test result threshold is increased, there is, as expected, a higher sensitivity but lower specificity.

Qualification by any one symptom category did not predict RDI thresholds as well as risk grouping did. Qualification by category 1 predicted RDI better than qualification by category 3 did, and qualification by either of these categories predicted RDI better than qualification by category 2 did (post-test probabilities, 78%, 70%, and 63%, respectively). By comparison, risk grouping resulted in a post-test probability of 85%.

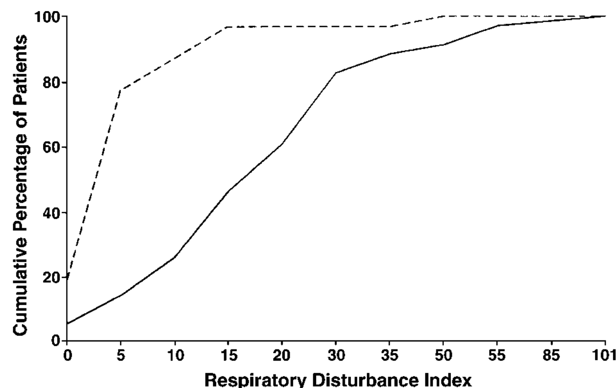

Figure. The respiratory disturbance index in a subset (13%) of 744 respondents. The cumulative distribution of the respiratory disturbance index for patients at high risk (n = 69; *solid line*) and those at lower risk (n = 31; *dashed line*) for sleep apnea is shown. The groups differed significantly ($P < 0.001$).

Discussion

More than one third (37.5%) of outpatients who visit urban primary care physicians report risk factors (body mass index > 30 kg/m^2 and hypertension) for and chronic behaviors (snoring, sleepiness, and tiredness) that suggest the presence of sleep disturbances and sleep apnea. A substantial proportion of these patients (4.4%) report being drowsy while driving more than three times per week. Nonetheless, primary care providers often do not ask patients about these symptoms, and sleep apnea frequently goes undiagnosed.

This report is the first to use a survey, the Berlin Questionnaire, to screen for sleep apnea in a primary care population. This approach seems acceptable to patients and may be more convenient and less costly than having the clinician screen by interview during the patient encounter. The moderate

Table 3. Risk Factors and Functional Sleepiness among Study Sites*

Site	Survey Return Rate (n = 744)	Patients Qualifying for Symptom Category 1 (n = 312)	Patients Qualifying for Symptom Category 2 (n = 231)	Patients Qualifying for Symptom Category 3 (n = 372)	Patients at High Risk for Sleep Apnea (n = 279)	Patients Who Experience Drowsy Driving (n = 137)
	←			%		→
1	90	41	31	59	41	12
2	57	37	23	55	29	19
3	50	38	30	43	29	22
4	100	48	35	51	45	21
5	72	41	33	40	36	22
Total	74	42	31	50†	37.5‡	18.4

* Patients who could not be categorized because of missing data were considered not to qualify for a particular symptom category and were therefore not included in a risk group.
† $P < 0.006$.
‡ $P < 0.001$.

Table 4. Risk Grouping and Diagnostic Test Thresholds

Respiratory Disturbance Index*	Patients at High Risk	Patients at Lower Risk	Sensitivity	Specificity	Pretest Probability	Positive Predictive Value	Likelihood Ratio
	n (%)						
≤5	10 (0.14)	24 (0.77)	0.77	0.89	0.31	0.71	5.34
>5	59 (0.86)	7 (0.23)	0.86	0.77	0.69	0.89	3.79
>15	37 (0.53)	1 (0.03)	0.54	0.97	0.69	0.97	16.62
>30	12 (0.17)	1 (0.03)	0.17	0.97	0.69	0.92	5.39

* Number of respiratory events per hour in bed.

return rate (74%) was explained not by patient refusal but by the variability of interest and application by site. The Berlin Questionnaire will need to be validated in other primary care settings, and testing thresholds must be defined.

In our study, the case recognition rate for sleep apnea among primary care physicians before the survey was 0.3%, a percentage similar to previous estimates (6, 7), and participating physicians believed that sleep apnea was unusual. Although many chronic illnesses (such as diabetes) remain undetected until a sentinel event (for example, myocardial infarction) occurs, the disparity between the current detection thresholds for sleep apnea and the prevalence estimates suggested by our study and by others (6) is extraordinary. Review of the literature indicates that detection of sleep apnea remains low, even after a sentinel event, such as a car crash that resulted from falling asleep at the wheel or the development of nocturnal angina (8).

Stoohs and colleagues (18) used an extensive battery of questions administered to patients face-to-face by volunteers. They estimated from symptom distributions that 20% of a primary care patient population might have sleep-disordered breathing. We used a patient-centered approach and risk grouping and found a somewhat greater prevalence. Possible explanations are that our patients responded to self-reporting in a more positive manner or that symptom severity was inflated in these urban practices. The prevalence of patients at high risk in our study is higher than estimates from community-based surveys and is similar to the estimates found in surveys in cardiovascular and sleep specialty clinics (1).

The prevalence of obesity (defined in our study as a body mass index > 30 kg/m^2) and patient-reported hypertension is similar to that found in other studies of adult primary care practices (19, 20). The links that we found between the presence of these traits and breathing disorders during sleep is not unexpected. However, reliance only on body mass index or hypertension to recognize the sleep apnea syndrome is unfounded. Many patients with a body mass index greater than 30 kg/m^2 (95 [34.4%]) or a history of high blood pressure (69 [35.6%]) in our study reported no snoring or sleepiness behavior. Furthermore, the predictive ability of the Berlin Questionnaire is higher when body mass index and high blood pressure (symptom category 3) are used in combination with snoring (symptom category 1) or sleepiness (symptom category 2) rather than alone.

Sex differences were seen in the reporting of symptoms; this finding appeared in previous studies (1). The issue has not been studied exclusively, but it may represent reporting bias or a difference in disease expression. Men reported a greater frequency of drowsy driving than did women, an observation consistent with findings from the Wisconsin cohort (21). This sex difference did not seem to affect the validity of risk groupings because both behaviors were captured in symptom category 2.

Sleepiness is linked to a poorer general health status (22) and to car crashes (23). Of concern is that 4.4% of respondents reported that they drove while drowsy almost every day. Even if we assume that all of the persons who did not respond to the questionnaire were nondrowsy drivers, the prevalence of risk for a crash caused by falling asleep at the wheel is still high (3%). The prevalence of any report of drowsy driving was 28% among respondents in the high-risk group and was still 13% among those at lower risk for sleep apnea. Such sleepiness is an important health issue, regardless of its cause (23, 24).

Portable monitoring was used to assess the validity of the risk grouping strategy. This technique has reasonable accuracy for counting events, despite both technical and testing sources of error, compared with attended, center-based polysomnography, which also has limitations (17, 24). Risk grouping by Berlin Questionnaire responses can detect patients who meet or exceed the RDI values used in diagnostic classifications of the obstructive sleep apnea–hypopnea syndrome (17, 24). We performed a preliminary analysis of the German version of the Berlin Questionnaire in 300 patients attending pulmonary and sleep clinic specialties by comparing survey responses with results of center-based polysomnography. Our results suggested that in this specialty population, the ability of the questionnaire to predict an elevated RDI was similar to that of polysomnography (Stoohs R, Netzer N. Unpublished

data). We conclude that the Berlin Questionnaire will detect important symptom distributions and permit risk grouping in the absence of a physician–patient encounter. The sensitivity of 86% for an RDI more than 5 is higher than that of strategies currently used in clinical practice. However, physician judgment is still needed to initiate a management system, to detect unusual cases, or to recognize causes for waketime sleepiness other than sleep apnea.

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