ORIGINAL RESEARCH

Identification by Primary Care Clinicians of Patients with Obstructive Sleep Apnea: A practice-based research network (PBRN) study

James W. Mold MD, MPH, Craig Quattlebaum, MS, and Eric Schinnerer, MS, Lindsay Boeckman, MS, William Orr, PhD, and Kimberly Hollabaugh, MS

Background: **Obstructive sleep apnea (OSA) is a reasonably common disorder that is associated with daytime tiredness and a host of medical conditions. Little is known about how primary care clinicians (PCCs) detect, diagnose, and manage patients who have OSA.**

Methods: **We gathered information from 44 randomly selected practices in 5 regional practice-based research networks. This included interviews with PCCs and sleep consultants, medical records abstraction, and patient surveys. Descriptive analyses of the quantitative data were used to describe the prevalence of sleep symptoms, the proportion of primary care patients at high risk for OSA, and the methods used by PCCs to detect and diagnose patients with OSA.**

Results: **More than 90% of adult patients visiting a PCC on any given day are experiencing sleep-related symptoms. Based on their Berlin Questionnaire scores, more than one third are at high risk of having sleep apnea. However, most patients have not discussed their sleep-related symptoms with their PCC, and fewer than one third have sleep-related symptoms documented in their medical records. Very few PCCs routinely screen for OSA, and, despite using billing records, problem lists, clinician and staff recall, and prospective logs enhanced by waiting room posters, PCCs were generally unable to identify 25 patients with OSA in their practices.**

Conclusions: **A substantial proportion of patients who see PCCs regularly are at high risk for OSA. Very few of them are being diagnosed or treated. Clearer guidelines and a systematic approach are needed if this is indeed a problem that should be addressed. (J Am Board Fam Med 2011;24:138–145.)**

Keywords: **Obstructive Sleep Apnea, Primary Care Clinician, Primary Care Provider, Sleep Disorders**

The Centers for Medicare and Medicaid Services' guidelines for coverage of positive pressure devices define significant obstructive sleep apnea (OSA) as an Apnea-Hypopnea Index (AHI) score ≥15 (≥15 apneic or hypopneic episodes per hour), or an AHI score of ≥5 with documentation of excessive daytime sleepiness, impaired cognition, mood disorders, insomnia, hypertension, ischemic heart disease, or stroke. Population-based samples of US adults estimate the prevalence of at least moderate OSA to be between 2% and 7%; these rates depend on, for example, whether the population studied included all adults or only those who are employed.[1–4] Obstructive sleep apnea is almost twice as common in men than in women, and 2 to 10 times more common in 60- to 70-year-olds than in 30- to 40-year-olds.[1,5–7] The 5-year incidence has been estimated to be as high as 10%, which reflects the effects of both age and a secular trend toward more risk factors, especially obesity, among the population.[5]

OSA is strongly associated with obesity, insulin resistance, diabetes mellitus, systemic hypertension, pulmonary hypertension, heart attacks, congestive heart failure, strokes, sleep-related

This article was externally peer reviewed.

Submitted 20 April 2010; revised 9 July 2010; accepted 12 July 2010.

From the Department of Family and Preventive Medicine (JWM) and the College of Medicine (CQ, ES), University of Oklahoma Health Sciences Center, Oklahoma City.

Funding: Funding was provided by the Centers for Medicare and Medicaid Services and the Agency for Healthcare Research and Quality grant HHSA290200710009I.

Conflict of interest: none declared.

Corresponding author: James W. Mold, MD, MPH, Department of Family and Preventive Medicine, University of Oklahoma Health Sciences Center, 900 NE 10th Street, Oklahoma City, OK 73104 (E-mail: james-mold@ouhsc.edu).

dysrhythmias, nocturnal angina, and excess mortality.[8–10] However, the degree to which these associations are causative is unclear. Probably because of excessive daytime drowsiness and impaired concentration, individuals with an AHI of >10 are 6.3 times more likely, and those with an AHI result≥34 are 15 times more likely, to be involved in a motor vehicle accident than those with an AHI of 0. Several studies have found that identification and treatment of OSA with continuous positive airway pressure (CPAP) devices reduces health care costs substantially, primarily because treatment of hypertension and cardiovascular disease, and treatment of OSA cuts hospital days in half.[11–14]

The 2 evidence-based guidelines registered with the National Guidelines Clearinghouse seem to make the assumption that identification of patients with OSA is a desirable goal. However, they stop short of recommending universal screening, suggesting that primary care clinicians (PCCs) identify patients at risk for OSA by taking into account risk factors such as obesity and increased neck circumference, using "a thorough review of systems," including questions related to OSA, and looking for medical conditions such as hypertension and cardiovascular diseases.[15]

Given the lingering uncertainties regarding the benefits and burdens associated with identification and treatment of OSA, as well as primary care processes that are often inadequate to assure that risk factors, reviews of systems, and medical conditions are systematically collected and combined into risk profiles, it should not be surprising that a majority of patients with OSA have not been identified. One study estimated that more than 80% of men and more than 90% of women with OSA remain undiagnosed.[3]

The purpose of this study was to determine how PCCs currently address these challenges. More specifically, we tried to determine the proportion of primary care patients at high risk for OSA, the methods used by PCCs to identify them, and the proportion of those at risk who have been diagnosed and treated.

Methods

We conducted a multimethod investigation in primary care practices recruited from 5 practice-based research networks (PBRNs) located in Oklahoma, Florida, Alabama, Connecticut, and California. We used computer-generated random number tables to reorder the membership lists for each PBRN, first by practice and then by clinician within each practice. The PBRN project coordinators then attempted to recruit and enroll one PCC per practice, beginning at the top of the list and working their way down until each PBRN had recruited 9 clinicians from 9 different practices.

Six types of data were collected from these clinicians and their practices: (1) semistructured interviews with the clinicians; (2) semistructured interviews with each clinician's sleep consultant; (3) data abstracted from the medical records of a random sample of patients ≥65 years of age who were not known to have OSA; (4) data abstracted from the medical records of a random sample of 25 patients who previously had been identified as having OSA; (5) surveys of consecutive consenting patients, 30 to 64 years of age, who were waiting to be seen by the clinicians; and (6) surveys of consecutive consenting patients, ≥65 years of age, who were waiting to be seen by the clinicians.

Patients who received a diagnosis of OSA were identified by the research team using billing records, electronic medical record problem lists, referral data, clinician and staff recall, and prospective logs kept within the practices for 1 to 3 months. The investigators provided participating clinicians with waiting room posters that encouraged patients with OSA to be sure their clinician was aware of it, in case, for instance, the diagnosis had been made by another clinician. Older patients were over-sampled because the study was funded, in part, by the Medicare program, which was particularly interested in older patients. Because one network was unable to collect patient surveys, 3 of the other networks collected additional surveys from the original and additional practices (see Table 1).

The 6 types of data were analyzed separately, providing different views of prevalence rates and routine clinical practices. During the interviews, PCCs were asked to describe their approaches to identifying patients with OSA, including any screening methods and screening tools used. They were also asked about diagnostic approaches, referral patterns, and rates of positive sleep tests. The sleep consultants were asked about referral patterns and rates of positive tests.

Table 1. Types of Data and Sample Sizes by Network

Network	PCC Interviews	Consultant Interviews	Chart Audits (OSA)	Chart Audits (Patients >65 Years Old)	Surveys (Patients 30–64 Years Old)	Surveys (Patients >65 Years Old)
OKPRN	9	6	128	226	316	255
APBRN	9	9	217	225	544	283
LANet	9	1	32	222	327	65
CCPC	9	1	191	208	170	131
SoFlaPBRN	8	1	121	140	0	0
Total	44	18	725	1.019	1,357	734

PCC, primary care clinician; OSA, obstructive sleep apnea; OKPRN, Oklahoma Physicians Resource/Research Network; APBRN, Alabama Practice-Based Research Network; LANet, Los Angeles Network; CCPC, Connecticut Center for Primary Care; SoFlaPBRN, South Florida Practice-Based Research Network.

Chart abstraction data from patients with OSA provided information about when, how, and by whom their problem was recognized. Chart abstraction data from older patients without sleep apnea was used to analyze sleep symptoms (trouble getting to sleep; daytime sleepiness; unintended sleep episodes; restless sleep; unrefreshing sleep; fatigue; trouble concentrating; waking up holding breath, choking, or gasping; snoring or apnea reported by bed partner; nocturnal angina; morning headache; and restless legs syndrome); risk factors recorded by clinicians (obesity, hypertension, congestive heart failure, cardiac arrhythmias, diabetes mellitus, metabolic syndrome, coronary artery disease, and cor pulmonale); and clinicians' diagnostic approaches (PSG, home sleep testing, nocturnal pulse oximetry, tape-recording of sounds produced during sleep, and a sleep diary).

The patient survey data, which included the Berlin Sleep Questionnaire,[16–19] provided an estimate of the proportion of patients at high risk for OSA, whether or not OSA was identified. The survey data also estimated the proportion of patients with sleep symptoms suggestive of sleep apnea, the proportion who had told their PCC about these symptoms and the proportion who had been diagnosed with sleep apnea. Surveyed patients were also asked for their current weight and height so that body mass index (BMI) could be estimated. Descriptive statistics were calculated for relevant variables.

We used Bayes' Theorem,

$PV+ = (Sn*prev) / [(Sn*prev) + (1 - Sp)*(1 - prev)]$

$PV- = [Sp*(1 - prev)] / [Sp*(1 -prev) + (1 - Sn)*prev]$,

to create a table that mapped positive predictive values (PV+) and negative predictive values (PV−) against predicted prevalence (prev) for the questionnaire's published sensitivity (Sn) of 0.86 and specificity (Sp) of 0.77. We treated the observed proportions of positive and negative results from the Berlin Questionnaire as provisional estimates of positive and negative predictive values, respectively, and used SAS PROC FREQ to calculate exact 95 confidence intervals (CI) for both proportions.

After using the table to map the lower and upper confidence limits to predicted prevalences, we reported the lowest and highest values obtained to estimate the true prevalence of OSA among adults in primary care practice waiting rooms. The calculation assumes that the study's participants constitute a random sample of all such adults.

Results

Characteristics of the participating clinicians and practices by network are shown in Table 2. Only 3 of the 44 practices fell below 15th on the practice randomization tables (all within the Connecticut Center for Primary Care network), and only 4 of the enrolled clinicians were randomized lower than 1st within their practices. In other words, a large proportion of invited practices participated, reducing the potential for selection bias. Total numbers of practices in each network were as follows: Oklahoma Physicians Resource/Research Network, 100 practices and 230 clinicians; South Florida PBRN, 37 practices and 42 clinicians; Alabama PBRN, 20 practice and 40 clinicians; ProHealth, 76 practices and 195 clinicians; and LANet, 16 practices and 250 clinicians.

Table 2. Characteristics of Participating Primary Care Clinicians and Their Practices

Network	Discipline		Patient Care FTE (Mean %)	Patients Seen Per Week (Mean)	Location of Practice*		
	FM (%)	GIM (%)			Rural (%)	Suburban (%)	Urban (%)
OKPRN	100	0	91	78	33	33	33
APBRN	100	0	94	115	56	44	0
LANet	100	0	100	104	0	33	67
CCPC	67	33	100	83	0	78	22
SoFlaPBRN	100	0	94	NA	0	63	47
All (Mean)	93	7	96	95	18	52	30

FM, family medicine; GIM, general internal medicine; FTE, full-time equivalent; OKPRN, Oklahoma Physicians Resource/Research Network; APBRN, Alabama Practice-Based Research Network; LANet, Los Angeles Network; CCPC, Connecticut Center for Primary Care; SoFlaPBRN, South Florida Practice-Based Research Network; NA, not available.
*Location of practice specified by practice based on predominant source of patients. Suburban refers to any location not considered rural or urban.

PCC Interviews

Only 10 of the 44 PCCs (23%) who were interviewed said that they routinely screen patients for OSA. Those who routinely screen said they use the review of systems and risk factors to identify high-risk patients. An additional PCC screens all diabetic patients.

Among PCCs who do not screen all patients, 3 use either the Berlin Questionnaire or the Epworth Sleepiness Scale to further evaluate patients who complain of sleep symptoms.

According to the PCCs, when they refer a patient for diagnostic testing (generally PSG), the results are positive 84% of the time (range, 50% to 100%).

Sleep Consultant Interviews

All of the PCCs could identify at least one sleep consultant. However, it proved difficult to recruit and enroll sleep consultants for the study even with the $150 incentive, so only 18 sleep consultant interviews were conducted. The consultants reported that 67% of their referrals for OSA diagnostic testing come from PCCs, 27% from subspecialists, and 6% through self-referral. They estimated that 85% (range, 70% to 99%) of polysomnograms done because of suspicion of OSA were positive.

Chart Abstractions

Older Patients without a Sleep Apnea Diagnosis

Sixty-one percent (626 of 1019) of the older patients whose records were abstracted were women. The mean age was 74.7 years (SD, 7.3 years; range, 65–101 years). Documented comorbidities included obesity in 10%, hypertension in 65%; diabetes mellitus in 26%; coronary artery disease in 13%; congestive heart failure in 4%; and cardiac arrhythmias in 4%. Approximately 27% had at least one sleep-related symptom recorded in their medical record.

The following proportions of patients had specific symptoms documented in their records: daytime sleepiness or unintentional sleep episodes, 4%; snoring, 3%; apneic events, 1%; and restless or unrefreshing sleep, 6% (Table 3). Only 9% of those with relevant comorbidities and/or documented symptoms had been sent by their current PCC for sleep studies.

Patients with Sleep Apnea

Though each PCC was asked to identify all of their adult patients with OSA, only 14 of the 45 PCCs could identify 25 patients in their practices with OSA despite using multiple methods (billing re-

Table 3. Proportions of Patients with Selected Sleep Symptoms Recorded in Their Medical Record

Symptoms	Patients Aged ≥65 Years, without OSA (n = 1,019)	Adult Patients with OSA before Diagnosis (n = 725)
Snoring	40 (4)	418 (58)
Apneic episodes	7 (1)	196 (27)
Unintentional sleep episodes	18 (2)	39 (5)
Daytime sleepiness	26 (3)	289 (40)
No sleep symptoms documented	743 (73)	129 (18)

Values provided as n (%).
OSA, obstructive sleep.

cords, problem lists, clinician/nurse recall) and having 3 months to do so using prospective logs and waiting room posters. The greatest number of patients with OSA who were identified by any of the PCCs was 26. One PCC admitted to never having identified a patient with OSA, and 4 practices could not identify a single patient with a known diagnosis of OSA.

Of the 725 patients with OSA whose records were abstracted, 43% were women. Their mean age was 52.7 years (SD, 13.8 years; range, 21–91 years). On average, OSA had been diagnosed 3 years earlier. Comorbid conditions included obesity (44%), hypertension (56%), diabetes mellitus (22%), coronary artery disease (7%), congestive heart failure (3%), and cardiac arrhythmias (3%). Eighty-three percent of these patients had sleep-related symptoms recorded in their medical records.

Fifteen percent had been diagnosed with OSA before seeing their current PCC. Among patients diagnosed by their current PCC, the specific symptoms documented before diagnosis were daytime sleepiness or unintentional sleep episodes (45%), snoring (58%), apneic events (27%), and restless or unrefreshing sleep (26%) (Table 3).

Patient Surveys

Younger Adults

Sixty-one percent (824 of 1357) of the younger adults surveyed in the primary care practice waiting rooms were women. Sixty-five percent were white, 16% were black, 2% were Asian, 2% were American Indian; and 25% were Hispanic. Their mean age was 47.5 years (SD, 9.9 years; range, 30–64 years). No information was available on the proportion of patients who agreed to be surveyed or about those who chose not to participate. The mean BMI of participants was 30.2 (SD, 7.6; range, 12.9–77.2; median, 29.0). Ten percent had been diagnosed with OSA, half before and half since being cared for by their current PCC. Ninety percent reported recently experiencing at least one sleep-related symptom. Only 22% said they had definitely discussed their sleep symptoms with their PCC. Hypertension was reported by 42%.

Some surveyed patients who were not previously diagnosed with OSA reported OSA-related symptoms, including snoring louder than talking (57%), apneic episodes (12%), daytime tiredness (65%), and falling asleep while driving (17%) (Table 4). Only 16.9% of these patients said they definitely had discussed their symptoms with their PCC. Of the 113 young adults surveyed who had had an overnight sleep test, 72% said that the test was positive.

Based on their Berlin Questionnaire scores, 48.8% of all younger adult patients including 47% of those who did not receive a diagnosis of OSA, were at high risk for OSA. Based on the questionnaire's published sensitivity and specificity, we estimated the true prevalence of OSA among these adults, 30 and 65 years of age, to be between 15% and 22%.

Older Adults (n = 734)

Approximately 60% of the older adults surveyed were women. Eighty-two percent were white, 10.3% were black, 1.1% were Asian, 1.1% were American Indian, and 9.5% were Hispanic. The mean age was 73.9 years (SD, 6.7 years; range, 65–96 years). Their mean BMI was 27.8 (SD, 6.5; range, 17–57.5; median, 27). Only about 7% had been diagnosed with OSA, 54% before and 46% since they began seeing their current PCC. Eighty-three percent reported recently experiencing at least one sleep-related symptom. Only 18% remembered having discussed their sleep symptoms

Table 4. Proportions of Patients with Sleep-Related Symptoms from Patient Surveys

	Patients without OSA		Patient with OSA	
Symptoms	30–64 Years (n = 1124)	≥65 Years (n = 630)	30–64 Years (n = 130)	≥65 Years (n = 46)
Snoring	643 (57)	291 (46)	113 (87)	33 (72)
Apnea	140 (12)	55 (9)	96 (74)	29 (63)
Falling asleep while driving	188 (17)	61 (10)	43 (33)	8 (17)
Daytime tiredness (>weekly)	734 (65)	310 (49)	113 (87)	29 (63)

Values provided as n (%).
OSA, obstructive sleep.

with their PCC. Sixty-one percent had hypertension.

Surveyed patients who were not diagnosed with OSA reported OSA-related symptoms, including snoring louder than talking (46%), apneic episodes (9%), daytime tiredness (49%), and falling asleep while driving (10%) (Table 4). Nearly 14% (13.6%) said they had discussed their symptoms with their PCC. Of the 47 older adults surveyed who had been tested, 62% said the test was positive.

Based on their Berlin Questionnaire scores, 38.6% of all older patient including 37.6% of those without a diagnosis of OSA, were at high risk for OSA. Based on the questionnaire's sensitivity and specificity, we estimated the true prevalence of OSA among these older adults to be between 12% and 25%.

Discussion

Our data suggest that nearly all patients who regularly visit PCCs have sleep-related symptoms, and that 30% to 40% of patients who see their PCC regularly are at high risk for OSA. However, only 20% of them spontaneously report their sleep symptoms to their PCC and, as a result, sleep symptoms are documented in the medical record of fewer than a third of patients. Few PCCs routinely screen patients for OSA, possibly, in part, because there are no published guidelines that provide specific recommendations about whether and how to screen. Clinicians who do screen use a review of systems as their primary screening tool and acknowledge that this is done only during annual physical examinations. However, if this method is to be recommended, it should be noted that annual examinations would presumably have to be performed for all patients older than 30 (but perhaps younger), and reviews of systems would need to be enhanced to include specific OSA symptoms because many currently do not.[20]

When PCCs do identify patients who have concerning symptoms or signs, they seem to only refer for diagnostic testing those patients who are sure have OSA. This is reflected in the extremely high rates of positive tests. As a result, we were able to identify fewer than 26 patients per practice, and no patients in 4 of the practices, with OSA.

The high rate of sleep-related symptoms among patients attending primary care practices supports an earlier study conducted in 10 practices within the Oklahoma Physicians Resource/Research Network, in which 363 consecutive adult patients were asked about specific symptoms. In that study, 99% of patients reported at least one sleep-related symptom.[21] In that same study, the mean BMI of was 31.2. Fifteen percent admitted to having fallen asleep while driving. In a larger study involving 1935 patients who were seen in 5 primary care practices in North Carolina, the proportion who experienced any sleep-related symptom was not reported, but more than 50% reported excessive daytime sleepiness, more than one-third had dozed off during daytime activities, and 13% reported that someone had witnessed apneic spells during sleep.[22] Not surprisingly, comorbidities known to be associated with OSA were common as well.

The proportion of patients at high risk for OSA is not surprising. When the Berlin Sleep Questionnaire was administered to 1506 adults who participated in the 2005 National Sleep Foundation's Sleep in America poll, 31% of men and 21% of women were found to be at high risk for OSA.[23] Patients being seen on any given day in primary care practices are obviously more likely to have symptoms and comorbidities than community population samples.

The generalizability of our findings is strengthened by our inclusion of primary care practices from 5 different states, by randomization of the practices and clinicians involved, by the reasonably large numbers of clinicians and patients included, and by the use of multiple data sources. Practices from rural, suburban, and urban locations were well represented. Residency program practices were not included. There was a reasonable racial and ethnic distribution among the patients who were surveyed.

However, all the clinicians were members of PBRNs, which probably make them different, though not dramatically so, from other primary care clinicians.[24–27] Patients of these clinicians, however, are probably not very different from patients of other PCCs.[25] Nearly all of the clinicians were family physicians; only 2 of the 44 were general internists. Though the medical records abstractions and patient surveys were standardized across the 5 networks, the clinician interviews and sleep consultant interviews were not identical, though they did cover the same topics. In many cases, those conducting the interviews did not pursue the clinical specifics far enough to be sure that

we fully understand what the clinicians really do in practice. We were not able to match the patients who were surveyed with their medical records, so those data are from 2 different sets of patients. In addition, because we chose medical records randomly rather than consecutively (as patients were seen) this subgroup of patients is distinctly different from the subgroup waiting to be seen by clinicians on any given day.

Nevertheless, we believe that we have been able to paint a fairly accurate picture of the current standard of primary care practice with regards to the identification of adult patients with OSA. If it is important for primary care clinicians to do a better job of this, they will probably need more specific guidelines and a more systematic approach. That may, for example, require some kind of annual visit during which a complete review of systems, which includes specific questions about sleep, is performed.

We would like to acknowledge the researchers from the other four practice-based research networks including John Ryan, Ph.D., (South Florida PBRN), T. Michael Harrington, M.D. (Alabama PBRN), John Lynch, M.P.H. (Connecticut Center for Priary Care), and Lyndee Knox, Ph.D. (LANet), their research colleagues and assistants, and the clinicians and staff from the participating practices.

References

1. Bixler EO, Vgontzas AN, Ten Have T, Tyson K, Kales A. Effects of age on sleep apnea in men: I. Prevalence and severity. Am J Respir Crit Care Med 1998;157:144–8.
2. Bixler EO, Vgontzas AN, Lin HM, et al. Prevalence of sleep-disordered breathing in women: effects of gender. Am J Respir Crit Care Med 2001;163(3 Pt 1): 608–13.
3. Young T, Evans L, Finn L, Palta M. Estimation of the clinically diagnosed proportion of sleep apnea syndrome in middle-aged men and women. Sleep 1997;20:705–6.
4. Young T, Palta M, Dempsey J, Skatrud J, Weber S, Badr S. The occurrence of sleep-disordered breathing among middle-aged adults. N Engl J Med 1993; 328:1230–5.
5. Tishler PV, Larkin EK, Schluchter MD, Redline S. Incidence of sleep-disordered breathing in an urban adult population: the relative importance of risk factors in the development of sleep-disordered breathing. JAMA 2003;289:2230–7.
6. Young T, Peppard PE, Gottlieb DJ. Epidemiology of obstructive sleep apnea: a population health perspective. Am J Respir Crit Care Med 2002;165:1217–39.
7. Duran J, Esnaola S, Rubio R, Iztueta A. Obstructive sleep apnea-hypopnea and related clinical features in a population-based sample of subjects aged 30 to 70 yr. Am J Respir Crit Care Med 2001;163(3 Pt 1):685–9.
8. Pagel JF. Obstructive sleep apnea (OSA) in primary care: evidence-based practice. J Am Board Fam Med 2007;20:392–8.
9. Young T, Skatrud J, Peppard PE. Risk factors for obstructive sleep apnea in adults. JAMA 2004;291: 2013–6.
10. Mehra R, Stone KL, Varosy PD, et al. Nocturnal arrhythmias across a spectrum of obstructive and central sleep-disordered breathing in older men: outcomes of sleep disorders in older men (MrOS sleep) study. Arch Intern Med 2009;169:1147–55.
11. Kapur V, Blough DK, Sandblom RE, et al. The medical cost of undiagnosed sleep apnea. Sleep 1999; 22:749–55.
12. Banno K, Manfreda J, Walld R, Delaive K, Kryger MH. Healthcare utilization in women with obstructive sleep apnea syndrome 2 years after diagnosis and treatment. Sleep 2006;29:1307–11.
13. Peker Y, Hedner J, Johansson A, Bende M. Reduced hospitalization with cardiovascular and pulmonary disease in obstructive sleep apnea patients on nasal CPAP treatment. Sleep 1997;20:645–53.
14. Ronald J, Delaive K, Roos L, Manfreda J, Bahammam A, Kryger MH. Health care utilization in the 10 years prior to diagnosis in obstructive sleep apnea syndrome patients. Sleep 1999;22:225–9.
15. US Department of Health and Human Services, Agency for Healthcare Research and Quality. National guidelines clearinghouse. Available from: http://www.guidelines.gov/. Accessed January 21, 2011.
16. Netzer NC, Stoohs RA, Netzer CM, Clark K, Strohl KP. Using the Berlin Questionnaire to identify patients at risk for the sleep apnea syndrome. Ann Intern Med 1999;131:485–91.
17. Ahmadi N, Chung SA, Gibbs A, Shapiro CM. The Berlin Questionnaire for sleep apnea in a sleep clinic population: relationship to polysomnographic measurement of respiratory disturbance. Sleep Breath 2008;12:39–45.
18. Chung F, Yegneswaran B, Liao P, et al. Validation of the Berlin Questionnaire and American Society of Anesthesiologists' checklist as screening tools for obstructive sleep apnea in surgical patients. Anesthesiology 2008;108:822–30.
19. Sharma SK, Vasudev C, Sinha S, Banga A, Pandey RM, Handa KK. Validation of the modified Berlin Questionnaire to identify patients at risk for the obstructive sleep apnoea syndrome. Indian J Med Res 2006;124:281–90.
20. Sorcher AJ. How is your sleep: a neglected topic for health care screening. J Am Board Fam Med 2008; 21:141–8.
21. Mold JW, Woolley JH, Nagykaldi Z. Associations between night sweats and other sleep disturbances: an OKPRN study. Ann Fam Med 2006;4:423–6.

22. Alattar M, Harrington JJ, Mitchell CM, Sloane P. Sleep problems in primary care: a North Carolina Family Practice Research Network (NC-FP-RN) study. J Am Board Fam Med 2007;20:365–74.
23. Hiestand DM, Britz P, Goldman M, Phillips B. Prevalence of symptoms and risk of sleep apnea in the US population: results from the national sleep foundation sleep in America 2005 poll. Chest 2006; 130:780–6.
24. Galliher JM, Bonham AJ, Dickinson LM, Staton EW, Pace WD. Representativeness of PBRN physician practice patterns and related beliefs: the case of the AAFP National Research Network. Ann Fam Med 2009;7:547–54.
25. Binns HJ, Lanier D, Pace WD, et al. Describing primary care encounters: the Primary Care Network Survey and the National Ambulatory Medical Care Survey. Ann Fam Med 2007;5:39–47.
26. Stange KC. Practice-based research networks. Their current level of validity, generalizability, and potential for wider application. Arch Fam Med 1993;2: 921–3.
27. Green LA, Miller RS, Reed FM, Iverson DC, Barley GE. How representative of typical practice are practice-based research networks? A report from the Ambulatory Sentinel Practice Network Inc (ASPN). Arch Fam Med 1993;2:939–49.