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Detecting obstructive sleep apnoea hypopnoea syndrome

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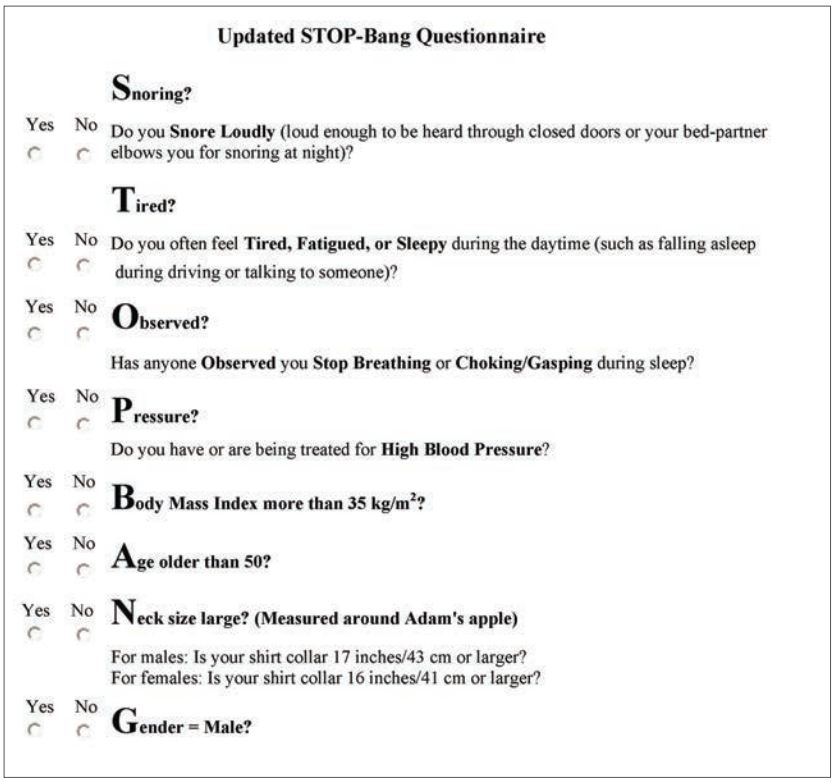

Updated STOP-Bang Questionnaire

Snoring?

Yes ○ No ○ Do you **Snore Loudly** (loud enough to be heard through closed doors or your bed-partner elbows you for snoring at night)?

Tired?

Yes ○ No ○ Do you often feel **Tired, Fatigued, or Sleepy** during the daytime (such as falling asleep during driving or talking to someone)?

Yes ○ No ○ **O**bserved?

Has anyone **Observed** you **Stop Breathing** or **Choking/Gasping** during sleep?

Yes ○ No ○ **P**ressure?

Do you have or are being treated for **High Blood Pressure**?

Yes ○ No ○ **B**ody Mass Index more than 35 kg/m²?

Yes ○ No ○ **A**ge older than 50?

Yes ○ No ○ **N**eck size large? (Measured around Adam's apple)

For males: Is your shirt collar 17 inches/43 cm or larger?
For females: Is your shirt collar 16 inches/41 cm or larger?

Yes ○ No ○ **G**ender = Male?

FIGURE 1
The STOP-Bang Questionnaire

What are the common risk factors?

What are the potential complications?

What are the management options?

OBSTRUCTIVE SLEEP APNOEA HYPOPNOEA SYNDROME (OSAHS) IS CHARACTERISED BY repeated episodes of partial or complete collapse of the upper respiratory passages (mainly the oropharyngeal tract) during sleep.

The reduction or cessation of airflow (known as hypopnoea and apnoea, respectively) leads to adverse physiological consequences, such as oxyhaemoglobin desaturation, fluctuations in blood pressure (BP) and heart rate, and arousals from sleep.[1]

These nocturnal events play a major role in the pathophysiology of OSAHS-induced morbidity including cardiovascular, cerebrovascular and metabolic complications associated with the disorder as well as mortality.

The disruption of sleep caused by repeated arousals results in daytime hypersomnolence, fatiguability, impaired memory, cognitive dysfunction and sleep-related accidents.

The majority of patients with OSAHS remain undiagnosed and untreated for several years. Potential barriers to seeking and receiving treatment include the stigma related to some features of the disease such as snoring, lack of access to sleep diagnostic services, cumbersome treatment options, and concerns about not being allowed to drive.[2]

'Up to 50% of OSAHS patients are not obese and 25% of those with moderate disease do not suffer from somnolence'

In addition, GPs may not be prompted to explore an early diagnosis, if patients do not present with sleepiness and a high body mass index (BMI). Up to 50% of OSAHS patients are not obese and 25% of those with moderate disease have neither subjective nor objective somnolence.[3]

OSAHS may result in lost productivity as well as comorbidities (such as hypertension, heart disease, diabetes, and depression) and motor vehicle and workplace accidents.[4] Following treatment, patients report longer average nightly sleep duration, and dramatic improvements in sleep quality, productivity and quality of life.[5]

PREVALENCE

Studies have reported a prevalence of OSAHS of 9-38% in adults, this variation is in part accounted for by differences in definition, sampling and populations.[6,7] In the presence of classical daytime symptoms, the severity of OSAHS can be categorised based on the number of apnoea or hypopnoeas recorded per hour of sleep, known as the apnoea-hypopnoea index (AHI).

Based on nocturnal sleep studies, OSAHS is stratified as: mild = AHI > 5/hr, moderate = AHI >15 to < 30/hr and severe = AHI ≥ 30/hr.[6] Most patients »

will present with snoring, daytime somnolence and nocturnal apnoeas/hypopnoeas. However, this is not essential for diagnosis as the physiological consequences of OSAHS may present in different ways. AHI is measured in a sleep laboratory by polysomnography or at home by a limited multichannel recording of cardiorespiratory events during sleep. A systematic review published in 2017 showed that for an AHI ≥15/hr, the prevalence of OSAHS in adults ranged from 6 to 17%.

Advancing age, male gender and high BMI are associated with higher prevalence.[7] Reports suggest that up to 4% of middle-aged men and 2% of middle-aged women are affected in the UK.

RISK FACTORS

The pathophysiology of OSAHS is multifactorial, and involves a dynamic reduction in upper airway dimensions that can be caused by anatomical (including craniofacial or oropharyngeal) abnormalities or functional alterations and increased pharyngeal collapsibility due to reduced neuromuscular compensation during sleep.[8,9]

Four key contributors to pathogenesis or phenotypes have been characterised including a narrow, crowded, or collapsible upper airway, anatomical compromise and non-anatomical factors such as ineffective pharyngeal dilator muscle function during sleep, a low threshold for arousal to airway narrowing during sleep, and unstable control of breathing (high loop gain).

Men are two to three times more commonly affected than premenopausal age-matched women.[10] It is postulated that hormonal differences in breathing control and upper respiratory muscle activation during sleep and gender-specific fat distribution may play a role. The prevalence in women increases after the menopause, which may be due to redistribution of body fat to the neck.[11]

Smoking-related airway inflammation contributes to a higher prevalence among regular smokers which improves in former smokers.[12]

Obesity is the strongest risk factor for developing OSAHS, and a correlation has been documented between neck circumference, BMI and AHI.[11] BMI >29 kg/m^2 increases the risk of OSAHS ten fold.[13] Increased fat deposition in the neck may lead to airway narrowing and an increase in the likelihood of airway collapse.

However, OSAHS also affects patients with a normal BMI and those who do not have anatomical abnormalities, suggesting that alternative mechanisms, such as instability of ventilatory control and reduced sleep arousal threshold, may play a role.[14]

DIAGNOSIS

During primary care consultations, any history of habitual snoring, unrefreshing sleep and daytime somnolence is important in suggesting the underlying possibility of OSAHS. When this is combined with a partner's account of nocturnal apnoeas or snoring pauses, the diagnosis becomes highly likely. Patients reporting chronic fatigue, deteriorating memory, cognitive dysfunction, resistant hypertension, sexual dysfunction, low mood along with cardiovascular, metabolic or cerebrovascular comorbidities should increase clinical suspicion.

OSAHS may sometimes coexist with other sleep disorders such as restless legs syndrome or periodic limb movement disorder.

A brief examination of the face, jaw and oropharynx is usually helpful in eliminating obvious anatomical factors such as retrognathia, enlarged adenoids, tonsils, uvula or tongue that may predispose to OSAHS.

There are several questionnaires and associated algorithms which improve the prediction of OSAHS in primary care albeit with reservations. The Epworth Sleepiness Scale, first published in 1991 and revised in 1997, has been used to quantify the impact of daytime somnolence while assessing patients with OSAHS. An ESS score ≥ 11 can be interpreted as showing excessive daytime sleepiness.[15] It is consistent with, but not diagnostic of, OSAHS. The Berlin questionnaire is an advanced assessment tool for initial screening. The first part focuses on snoring, the second on breathing pauses and daytime sleepiness, and the third on the presence of obesity and hypertension.[16]

The STOP-Bang Questionnaire was specifically developed to meet the need for a reliable and easy to use screening tool (see figure 1, pll. It consists of eight (yes/no) items related to the clinical features of sleep apnoea: snoring, tiredness, observed apnoea, high BP, BMI, age, neck circumference, and male gender. The total score ranges from 0 to 8. Patients can be classified for OSAHS risk based on their respective scores.

The sensitivity of a STOP-Bang score ≥ 3 to detect moderate and severe OSAHS is estimated as 93% and 100%, respectively. Corresponding negative predictive values are 90% and 100%.[17]

However, screening questionnaires or clinical features alone, are insufficient to diagnose OSAHS and therefore not useful in excluding significant nocturnal events.[18] Any patient presenting with classical features and scoring appropriately on the screening questionnaire should be referred to a sleep disorders unit for diagnosis and management.

Criteria for urgent referral for adults are set out in table 1, below. (Children should be referred to a paediatric ear, nose and throat specialist if they have adenotonsillar hypertrophy and symptoms of persistent snoring.)

The most important investigation for diagnosis is an overnight sleep study, of which there are three types: full polysomnography, respiratory polygraphy and overnight oximetry.

Polysomnography is considered to be the gold standard. This test involves assessment of oximetry, snoring, chest, body and limb movements, as well as an electrocardiogram electroencephalogram, electro-oculogram and electromyogram.[11]

Overnight pulse oximetry showing repetitive saw tooth oscillations in the oxyhaemoglobin saturation on a time-compressed profile (> 4% from baseline) has a high specificity for OSAHS but the sensitivity is low. When combined with measurement of snoring, heart rate variability, limb movement and respiratory flow/effort in a multichannel sleep polygraphy, the sensitivity and

Table 1

Criteria for urgent referral

- Features suggestive of a head or neck cancer
- Symptoms of daytime sleepiness while driving or working with machinery or employment in high risk jobs (for example bus or lorry drivers)
- Signs of respiratory or heart failure
- Symptoms suggestive of severe OSAHS and coexistent COPD
- Where there are concerns about job security, ensure through personal communication with the sleep unit that diagnosis and treatment can be completed within four weeks of referral

specificity approaches that of polysomnography. It has the advantage of being inexpensive and portable and can be used in the patient's home. If OSAHS is clinically suspected, a negative home based sleep test should be followed by a repeat polygraphy or a full polysomnography, see figure 2, right.

COMPLICATIONS

The vast body of research in OSAHS postulates an associative and often a causative link with cardiovascular, cerebrovascular, metabolic, respiratory and mental health problems.[19]

Coronary artery disease and mortality

Severe disease is associated with an increased risk of:

- Coronary heart disease (CHD); relative risk (RR) 1.63 (95% CI: 1.18-2.26; P = 0.003)
- Stroke RR 2.15 (95% CI: 1.42-3.24; P < 0.001)
- Cardiac death; RR 2.96 (95% CI: 1.45-6.01; P = 0.003)
- All-cause mortality RR 1.54 (95% CI: 1.21-1.97; P < 0.001)

While moderate disease is associated with increased risk of CHD RR 1.38 (95% CI: 1.04-1.83; P = 0.026).[20]

Hypertension

A longitudinal study of moderate weight change and sleep-disordered breathing (n = 709) demonstrated a linear, dose-dependent relationship between OSAHS severity at baseline and relative risk of developing hypertension during follow-up.[13] There is also a recognised bidirectional association between OSAHS and systemic hypertension. Patients with this syndrome exhibit a high prevalence of non-dipping or rising circadian patterns, which are thought to contribute to organ damage in the heart and brain. OSAHS is the most common secondary cause of resistant hypertension and hence should be an essential part of investigation in relevant patients. Effective treatment significantly reduces BP in these patients.[21]

Atrial fibrillation

There is a high prevalence of cardiac arrhythmias in patients with OSAHS. Atrial fibrillation is four times more likely in these patients, independent of confounding factors such as systemic hypertension, obesity and heart failure. In the ORBIT-AF (Outcomes Registry for Better Informed Treatment of Atrial Fibrillation), involving more than 10,000 AF patients, those with coexisting OSAHS had significantly worse symptoms of AF and were more likely to be on rhythm control therapy.

In addition, OSAHS patients on appropriate treatment were significantly less likely to progress to permanent AF.[22]

Metabolic syndrome

Metabolic syndrome, i.e. the prediabetic state associated with central obesity and increased cardiovascular risk is highly prevalent in patients with OSAHS.[23] It is hypothesised that OSAHS may contribute to the pathogenesis of insulin resistance, which is the main feature of metabolic syndrome via intermittent hypoxia and fragmented sleep. A recent randomised, controlled, crossover study showed that effective »

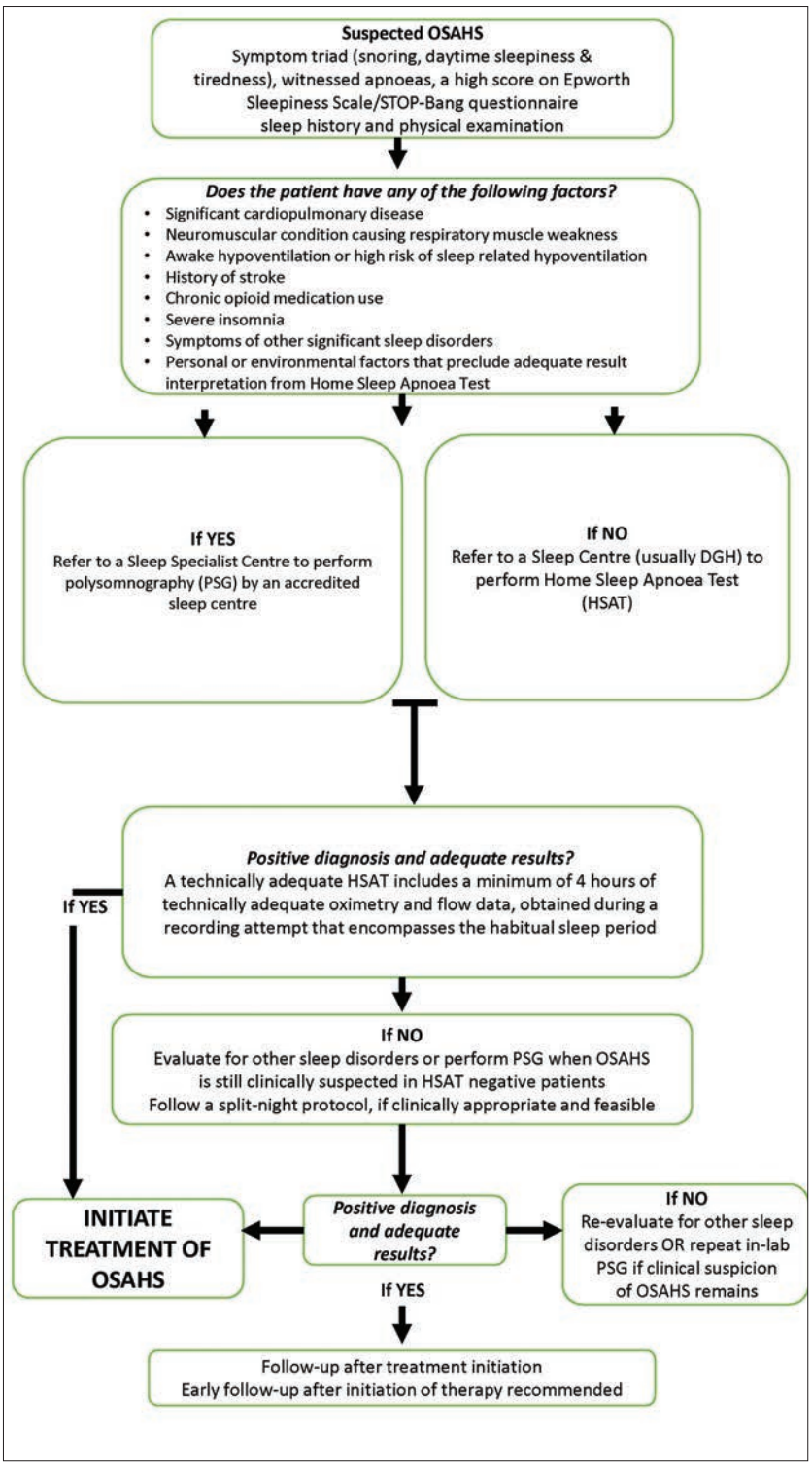

FIGURE 2
Diagnostic flowchart for obstructive sleep apnoea hypopnoea syndrome (OSAHS) in primary care

key points

SELECTED BY

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Obstructive sleep apnoea hypopnoea syndrome (OSAHS) is characterised by repeated episodes of partial or complete collapse of the upper respiratory passages, mainly the oropharyngeal tract, during sleep. The reduction or cessation of airflow, known as hypopnoea and apnoea, respectively, leads to adverse physiological consequences, such as oxyhaemoglobin desaturation, fluctuations in BP and heart rate, and arousals from sleep.

The apnoea-hypopnoea index (AHI) is the number of apnoeas or hypopnoeas recorded per hour of sleep. Based on nocturnal sleep studies, OSAHS is stratified as: mild = AHI > 5/hr, moderate = AHI >15 to < 30/hr and severe = AHI ≥ 30/hr. Most patients will present with snoring, daytime somnolence and nocturnal apnoeas/hypopnoeas. However, this is not essential for diagnosis as the physiological consequences of OSAHS may present in different ways. Obesity is the strongest risk factor for OSAHS; other risk factors include smoking, excessive drinking, sedatives and hypnotics.

Habitual snoring, unrefreshing sleep and daytime somnolence suggests the possibility of OSAHS. When this is combined with a partner's account of nocturnal apnoeas or snoring pauses, the diagnosis becomes highly likely. A history of chronic fatigue, deteriorating memory, cognitive dysfunction, resistant hypertension, sexual dysfunction or low mood in association with cardiovascular, metabolic or cerebrovascular comorbidities should increase clinical suspicion. A brief examination of the face, jaw and oropharynx should be performed to identify any anatomical factors, such as retrognathia, enlarged adenoids, tonsils, uvula or tongue, that may predispose to OSAHS.

The Epworth Sleepiness Scale can be used to quantify the impact of daytime somnolence. The STOP-Bang Questionnaire consists of eight (yes/no) items related to the clinical features of sleep apnoea: snoring, tiredness, observed apnoea, high BP, BMI, age, neck circumference, and male gender. Negative screening results or the absence of clinical features by themselves should not be used to rule out OSAHS.

OSAHS is a risk factor for hypertension and the most common secondary cause of resistant hypertension. Metabolic syndrome is highly prevalent in OSAHS and effective treatment of OSAHS has been shown to reduce BP, triglycerides, and visceral fat significantly. Moderate and severe OSAHS are associated with an increased risk of CHD, and severe OSAHS with a raised risk of stroke.

In mild OSAHS, oral appliances, such as the mandibular advancement device, may be preferable to continuous positive airway pressure therapy (CPAP). In moderate to severe OSAHS, CPAP has been shown to achieve a clinically significant reduction in disease severity, sleepiness, BP and motor vehicle accidents, and to improve sleep-related quality of life.

treatment of OSAHS with continuous positive airway pressure (CPAP) for three months significantly reduced several components of metabolic syndrome, including BP, triglyceride levels, and visceral fat.[24]

Cerebrovascular disease

The association between sleep and dementia is complex. Brain pathology underlying dementia may lead to disturbed sleep, sleep disturbance may contribute to the development of dementia, and co-occurring sleep disturbances and dementia may lead to a more rapid decline. Disturbed sleep as early as middle-age may increase the risk of dementia; this could have significant implications for prevention.[25]

Mood disorders

The prevalence studies indicate that there may be an increased prevalence of OSAHS in individuals with major depressive disorder and post traumatic stress disorder (PTSD), despite considerable heterogeneity and a high risk of bias. There is insufficient evidence to support increased OSAHS in schizophrenia, bipolar and anxiety disorders other than PTSD. However, emotional dysregulation triggered by sleep deprivation may pose an increased risk of relapse in patients with bipolar disorder. Studies of treatment of OSAHS indicate an improvement in both OSAHS and psychiatric symptoms.[26]

Accidents

Compared with controls, the odds of a work accident were found to be nearly double in workers (including professional drivers) with OSAHS; odds ratio (OR) 2.18 (95% CI: 1.53-3.10).[27] In a meta-analysis, overall, the odds that a driver with untreated OSAHS will have a crash are 243% higher than a driver without OSAHS. The meta-analysis estimated that 95% of drivers with untreated OSAHS have a crash risk that ranges from 21% to as high as 489% higher than those without OSAHS which is shown to be ameliorated with treatment. In the UK, the Driver Vehicle Licensing Agency needs to be informed of a formal diagnosis of OSAHS and confirmatory evidence is usually required of compliance with treatment for maintaining legal eligibility to drive.[28]

MANAGEMENT

The aim of treatment is to alleviate symptoms of OSAHS, improve patients' quality of life, and reduce the burden of complications. The treatment strategy should be tailored to the severity of OSAHS and range of comorbidities. Strategies involving maxillofacial and upper airway surgery are effective in the subset of patients with specific anatomical abnormalities.

Continuous positive airway pressure

A large meta-analysis demonstrated that CPAP results in a clinically significant reduction in disease severity, sleepiness, BP, and motor vehicle accidents, and improvement in sleep-related quality of life.[30] CPAP uses mild airway pressure administered via a compressor that functions to keep the airways open during sleep.[11] The goal of CPAP therapy is to suppress daytime somnolence and improve daytime functioning. For patients with severe OSAHS, CPAP use has been shown to have a beneficial effect on alleviating symptoms, improving quality of life and reducing the burden of comorbidities. However, the benefits of CPAP depend on adherence, and compliance has been shown to be a potential hurdle.[11] For patients with mild to moderate OSAHS, the duration of CPAP may be too little to reverse the chronic effects of OSAHS.[11]

Oral appliances

For patients with mild to moderate OSAHS, oral appliances, such as the mandibular advancement device, may be a preferred method of treatment to CPAP. The use of such devices during sleep has been shown to reduce symptoms. However, evidence suggests that CPAP remains superior in reducing OSAHS parameters (e.g. AHI and sleep fragmentation) recorded on polysomnography.[29] However, in clinical practice, patients may prefer oral appliances, and better compliance compared with CPAP may counterbalance the inferior efficacy of oral appliances in reducing AHI.[11]

Lifestyle measures

Since obesity is a major risk factor for OSAHS, weight loss is an important goal in management. Randomised studies have shown that lifestyle intervention with weight reduction can result in a significant reduction in hypopnea and apnoea indices in patients.[30] In a 12-month observational study, 48% of patients with originally severe OSAHS who had undergone CPAP with an adjuvant weight loss programme no longer required CPAP, and one in ten patients experienced total remission.[31] In addition to improving OSAHS, weight reduction will also improve other obesity-related metabolic conditions, such as the increased risk of type 2

diabetes and cardiovascular disease.[30]

However, programmes involving lifestyle changes have high failure rates over the long term.[32] Bariatric surgery, including gastric bypass and bandage, is an effective mode of weight loss in severely obese patients (BMI > 40 kg/m^2) who have been unsuccessful with conventional weight loss programmes.[33]

Patients should also be encouraged to avoid risk factors such as smoking, excessive alcohol consumption and the use of sedatives and hypnotics.[32,33]

CONCLUSION

OSAHS is a multifactorial disorder resulting from a complex interplay between anatomical and functional factors leading to nocturnal apnoea/hypopnoea associated with arousal from sleep with long-term physiological sequelae for the sufferer.

The consequences for the individual and society are huge in terms of impaired daytime performance, increased risk of accidents, significant increase in vascular complications and cognitive decline.

Different management strategies are available for patients which should be tailored to the severity of OSAHS and associated comorbidities. Oral appliances for mild OSAHS and CPAP for moderate to severe disease states remain the gold standard of therapy although this is most effective when combined with weight loss and lifestyle modification. However, the greatest challenge is improving early detection as the majority of patients remain undiagnosed for several years.

During any primary care consultation, attention to the triad of snoring, unrefreshing sleep and daytime somnolence plus the use of a predictive questionnaire (such as the STOP-Bang Questionnaire) may be helpful in alerting GPs to the possibility of underlying OSAHS. This is particularly important in patients with vascular or metabolic comorbidities where effective treatment may modify long-term complications. Where driving is affected, there is a legal obligation to diagnose and treat OSAHS urgently.

Preventative strategies, such as electrical stimulation of the upper airway, are emerging, and in the future may form part of the clinical approach to this disorder.[32]

Competing interests: None

REFERENCES

1 Balk EM, Moorthy D, Obadan NO et al. Diagnosis and treatment of obstructive sleep apnea in adults. Report No.: 11-EHC052. AHRQ comparative effectiveness reviews. Agency for Healthcare Research and Quality (US). Rockville MD, USA. 2011

2 Simpson L, Hillman DR, Cooper MN et al. High prevalence of undiagnosed obstructive sleep apnoea in the general population and methods for screening for representative controls. *Sleep Breath* 2013;17(3):967-73

3 Watson NF. Health care savings: The economic value of diagnostic and therapeutic care for obstructive sleep apnea. *J Clin Sleep Med* 2016;12(8):1075-77

4 American Academy of Sleep Medicine. Hidden health crisis costing America billions. Underdiagnosing and undertreating obstructive sleep apnea draining healthcare system. Frost & Sullivan. Darien IL, USA. 2016 www.aasmnet.org/sleep-apnea-economic-impact.aspx

5 American Academy of Sleep Medicine. In an age of constant activity, the solution to improving the nation's health may lie in helping it sleep better. What benefits do patients experience in treating their obstructive sleep apnea? Frost & Sullivan. Darien IL, USA. 2016

6 Force USPST, Bibbins-Domingo K, Grossman DC et al. Screening for obstructive sleep apnea in adults: US Preventive Services Task Force Recommendation Statement. *JAMA* 2017;317(4):407-14

7 Senaratna CV, Perret JL, Lodge CJ et al. Prevalence of obstructive sleep apnea in the general population: A systematic review. *Sleep Med Rev* 2017;34:70-81

8 Osman AM, Carter SG, Carberry JC, Eckert DJ. Obstructive sleep apnea: current perspectives. *Nat Sci Sleep* 2018;10:21-34

9 Jordan AS, McSharry DG, Malhotra A. Adult obstructive sleep apnoea. *Lancet* 2014;383(9918):736-47

10 Quintana-Gallego E, Carmona-Bernal C, Capote F et al. Gender differences in obstructive sleep apnea syndrome: a clinical study of 1166 patients. *Respir Med* 2004;98(10):984-89

11 Levy P, Kohler M, McNicholas WT et al. Obstructive sleep apnoea syndrome. *Nat Rev Dis Primers* 2015;1:15015

12 Wetter DW, Young TB, Bidwell TR. Smoking as a risk factor for sleep-disordered breathing. *Arch Intern Med* 1994;154(19):2219-24

13 Peppard PE, Young T, Palta M, Skatrud J. Prospective study of the association between sleep disordered breathing and hypertension. *N Engl J Med* 2000;342:1378-84

14 Tietjens JR, Claman D, Kezirian EJ et al. Obstructive sleep apnea in cardiovascular disease: a review of the literature and proposed multidisciplinary clinical management strategy. *J Am Heart Assoc* 2019;8(1):e010440

15 Johns MW. A new method for measuring daytime sleepiness: the Epworth sleepiness scale. *Sleep* 1991;14(6):540-45

16 Tan A, Yin JD, Tan LW et al. Using the Berlin Questionnaire to predict obstructive sleep apnea in the general population. *J Clin Sleep Med* 2017;13(3):427-32

17 Chung F, Abdullah HR, Liao P. STOP-Bang Questionnaire: A practical approach to screen for obstructive sleep apnea. *Chest* 2016;149(3):631-38

18 Kapur VK, Auckley DH, Chowdhuri S et al. Clinical practice guideline for diagnostic testing for adult obstructive sleep apnea: An American Academy of Sleep Medicine clinical practice guideline. *J Clin Sleep Med* 2017;13(3):479-504

19 Mokhlesi B, Ham SA, Gozal D. The effect of sex and age on the comorbidity burden of OSA: an observational analysis from a large nationwide US health claims database. *Eur Respir J* 2016;47(4):1162-69

20 Xie C, Zhu R, Tian Y, Wang K. Association of obstructive sleep apnoea with the risk of vascular outcomes and all-cause mortality: a meta-analysis. *BMJ Open* 2017;7(12):e013983

21 Liu L, Cao Q, Guo Z, Dai Q. Continuous positive airway pressure in patients with obstructive sleep apnea and resistant hypertension: A meta-analysis of randomized controlled trials. *J Clin Hypertens* 2016;18(2):153-58

22 Holmqvist F, Guan N, Zhu Z et al. Impact of obstructive sleep apnea and continuous positive airway pressure therapy on outcomes in patients with atrial fibrillation - Results from the Outcomes Registry for Better Informed Treatment of Atrial Fibrillation (ORBIT-AF). *Am Heart J* 2015;169(5):647-54 e2

23 Xu S, Wan Y, Xu M et al. The association between obstructive sleep apnea and metabolic syndrome: a systematic review and meta-analysis. *BMC Pulm Med* 2015;15:105

24 Drager LF, Togeiro SM, Polotsky VY, Lorenzi-Filho G. Obstructive sleep apnea: a cardiometabolic risk in obesity and the metabolic syndrome. *J Am Coll Cardiol* 2013;62(7):569-76

25 Wennberg AMV, Wu MN, Rosenberg PB, Spira AP. Sleep disturbance, cognitive decline, and dementia: A review. *Semin Neurol* 2017;37(4):395-406

26 Gupta MA, Simpson FC. Obstructive sleep apnea and psychiatric disorders: a systematic review. *J Clin Sleep Med* 2015;11(2):165-75

27 Garbarino S, Guglielmi O, Sanna A et al. Risk of occupational accidents in workers with obstructive sleep apnea: systematic review and meta-analysis. *Sleep* 2016;39(6):1211-18

28 Tregear S, Reston J, Schoelles K, Phillips B. Continuous positive airway pressure reduces risk of motor vehicle crash among drivers with obstructive sleep apnea: systematic review and meta-analysis. *Sleep* 2010;33(10):1373-80

29 Phillips CL, Grunstein RR, Darendeliler MA et al. Health outcomes of continuous positive airway pressure versus oral appliance treatment for obstructive sleep apnea: a randomized controlled trial. *Am J Respir Crit Care Med* 2013;187(8):879-87

30 Tuomilehto H, Seppa J, Uusitupa M. Obesity and obstructive sleep apnea--clinical significance of weight loss. *Sleep Med Rev* 2013;17(5):321-29

31 Johansson K, Neovius M, Lagerros YT et al. Effect of a very low energy diet on moderate and severe obstructive sleep apnoea in obese men: a randomised controlled trial. *BMJ* 2009;339:b4609

32 Spicuzza L, Caruso D, Di Maria G. Obstructive sleep apnoea syndrome and its management. *Ther Adv Chronic Dis* 2015;6(5):273-85

33 Ashrafian H, Toma T, Rowland SP et al. Bariatric surgery or non-surgical weight loss for obstructive sleep apnoea? A systematic review and comparison of meta-analyses. *Obes Surg* 2015;25(7):1239-50

Useful information

The Sleep Apnoea Trust Association
www.sleep-apnoea-trust.org

British Lung Foundation
www.blf.org.uk/support-for-you/osa

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