Obstructive sleep apnoea in adults

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Received 25 July 2012
Revised 19 September 2012
Accepted 14 October 2012
Published Online First
17 November 2012

To cite: Usmani ZA, Chai-Coetzer CL, Antic NA, *et al*. *Postgrad Med J* 2013;**89**:148–156.

ABSTRACT

Obstructive sleep apnoea (OSA) is characterised by repetitive closure of the upper airway, repetitive oxygen desaturations and sleep fragmentation. The prevalence of adult OSA is increasing because of a worldwide increase in obesity and the ageing of populations. OSA presents with a variety of symptoms the most prominent of which are snoring and daytime tiredness. Interestingly though, a significant proportion of OSA sufferers report little or no daytime symptoms. OSA has been associated with an increased risk of cardiovascular disease, cognitive abnormalities and mental health problems. Randomised controlled trial evidence is awaited to confirm a causal relationship between OSA and these various disorders. The gold standard diagnostic investigation for OSA is overnight laboratory-based polysomnography (sleep study), however, ambulatory models of care incorporating screening questionnaires and home sleep studies have been recently evaluated and are now being incorporated into routine clinical practice. Patients with OSA are very often obese and exhibit a range of comorbidities, such as hypertension, depression and diabetes. Management, therefore, needs to be based on a multidisciplinary and holistic approach which includes lifestyle modifications. Continuous positive airway pressure (CPAP) is the first-line therapy for severe OSA. Oral appliances should be considered in patients with mild or moderate disease, or in those unable to tolerate CPAP. New, minimally invasive surgical techniques are currently being developed to achieve better patient outcomes and reduce surgical morbidity. Successful long-term management of OSA requires careful patient education, enlistment of the family's support and the adoption of self-management and patient goal-setting principles.

INTRODUCTION AND BACKGROUND

Obstructive sleep apnoea (OSA) is characterised by repetitive, partial or complete closure of the upper airway resulting in repeated, reversible blood oxygen desaturation and sleep fragmentation. In the general population, the prevalence of adult OSA was found in the 1990s to be approximately 20% when defined as an apnoea hypopnoea index (AHI) >5 events/h of sleep.[1] The prevalence of 'OSA syndrome', a clinical entity defined by an elevated AHI in conjunction with daytime sleepiness, was estimated to be 4% in adult men and 2% in adult women.[2] However, given the recent global trend for increasing obesity and ageing of populations, it is likely that there has been a substantial increase in the prevalence of OSA. A recent Brazilian study, for example, showed that one-third of people had an AHI>5 (with symptoms) or AHI>15.[3] Several studies have shown a higher prevalence of OSA in older individuals;[4] however, some studies suggest that OSA in the elderly may be a condition distinct from that of OSA in middle age.[5] OSA is more prevalent in men than in women with an approximate ratio of 2 : 1.However, there is little gender difference after the sixth decade of age. Population-based studies have suggested a higher prevalence of OSA amongst African–Americans compared with Caucasians, even after controlling for body mass index (BMI).[6 7] Asians develop OSA at a mean BMI 2 kg/m^2 less than Caucasians. It is thought that the increased susceptibility to OSA in Asians is due to differences in craniofacial and upper airway anatomy.[8]

During the last two decades, there have been major advances in the understanding of how recurrent upper airway obstruction occurs during sleep in OSA. Obesity is the most important risk factor for OSA. An 8-year population-based study with 690 subjects found that a 10% weight gain predicted a 32% increase in AHI, while a 10% weight loss predicted a 26% decrease in AHI.[9] A narrowed pharyngeal airway due to increased fat deposition in surrounding structures,[10] and reduced longitudinal traction on the upper airway due to increased abdominal loading,[11] predisposes the airway to collapse at sleep onset when upper airway dilator muscle tone falls. Other factors that can lead to upper airway narrowing are tonsillar hypertrophy, retrognathia and other forms of craniofacial constriction. The severity and frequency of obstructive events during sleep is then determined by a complex interplay of four main factors: (1) the severity of the underlying anatomic deficiency; (2) the intrinsic stability/instability of the respiratory control system (often referred to as 'respiratory loop gain'); (3) the capacity of the dilator muscles to mount a neuromuscular compensatory response to obstruction and (4) the intrinsic sensitivity of the individual to be aroused from sleep when obstruction occurs.[12] Other factors, such as the surface tension of the upper airway lining fluid, which may influence airway collapsibility, and alcohol and sedating medication, which can suppress protective reflexes, may also influence the severity of OSA.[13 14]

A wide range of clinical manifestations are associated with untreated OSA as shown in box 1.

Snoring (as reported by the bed partner) and excessive daytime sleepiness (EDS) are the most common symptoms that lead patients to seek medical attention. However, perception and reporting of daytime sleepiness seem to vary greatly among individuals, and subjective tools to measure EDS, such as the Epworth Sleepiness Scale (ESS), do not correlate well with the severity of OSA.[15]

Box 1 Common symptoms and signs associated with obstructive sleep apnoea

Daytime symptoms:
- Sleepiness
- Morning headache
- Tiredness and fatigue
- Reduced vigilance and executive function
- Memory impairment
- Depression
- Impotence

Nocturnal symptoms:
- Snoring
- Apnoeas observed by the bed partner
- Sudden choking or gasping awakenings/arousals

Common clinical signs:
- Obesity which manifests as
  - Increased neck and/or waist circumference
  - Oropharynx that is crowded, narrowed or oedematous
  - Large tongue which sits high in the mouth and obscures a view of the oropharynx

Less common signs
- Retrognathia
- Tonsillar hyperplasia or hypertrophy
- Coexisting hypertension
- Peripheral oedema or signs of mild pulmonary hypertension

DIAGNOSIS

The diagnosis and decisions regarding treatment of OSA require consideration of potential risk factors, severity and impact of patient symptoms, bed partner history, medical comorbidities, plus the number of sleep-disordered breathing events and severity of oxygen desaturation detected during overnight sleep monitoring. A number of screening questionnaires and clinical prediction tools have been developed to help identify patients at high risk for OSA who may benefit from more urgent evaluation and treatment. Examples of screening tools developed for use in the sleep clinic setting include the Multivariable Apnoea Risk index[16] (based on snorting and gasping, loud snoring, breathing cessation, BMI, age and sex), and the Sleep Apnoea Clinical Score[17] (SACS) (based on neck circumference, hypertension, habitual snoring and partner reports of nocturnal choking or gasping). Researchers have also evaluated the role of anatomical measures of the upper airway and craniofacial structures in the prediction of OSA risk,[18 19] including the use of quantitative analysis of facial photographs.[20] OSA screening tools have also been designed for use outside of the sleep clinic setting. These include the STOP (snoring, daytime tiredness, observed apneas, have or been treated for blood pressure) questionnaire[21] which was developed for patients attending surgical preoperative assessment clinics, and the OSA50[22] (based on waist circumference, snoring, witnessed apnoeas and age ≥50) and Berlin questionnaires[23] which were created for use in the primary care population.

The current standard for confirmation of a diagnosis of OSA is laboratory polysomnography (PSG) which includes a comprehensive recording of EEG, electro-occulography (EOG) and chin electromyography (EMG) to identify sleep stages, as well as airflow, respiratory effort, body position, limb movements, ECG and oxygen saturation. Cessation of airflow for at least 10 s is defined as an apnoea. A hypopnoea is a ≥10 s reduction in airflow associated with an EEG arousal or oxyhaemoglobin desaturation. The AHI is the number of apnoeas and hypopnoeas per hour of sleep, and is the key measure used for quantifying disease severity and for defining disease prevalence in normal and clinical populations. Several definitions for hypopnoea have been proposed and are in clinical use.[24 25] These can markedly affect the AHI value.[25] Thus, care should be taken when comparing research and clinical studies between laboratories.

A growing number of portable sleep monitoring systems are being developed for use in a patient's own home without the need for an attending sleep technician. Many of these exclude the recording channels used for scoring sleep. In 1994, the task force for the Standards of Practice Committee of the American Sleep Disorders Association (now the American Academy of Sleep Medicine (AASM)) classified the different types of sleep apnoea evaluation studies into four levels according to the number of parameters recorded and the presence or absence of attending personnel:[26]

Type 1: Standard in-laboratory PSG, performed with an attending sleep technician, with a minimum of seven recording channels (EEG, EOG, chin EMG, ECG, airflow, respiratory effort and oxygen saturation). Additional channels for detection of snoring and body position are also usually employed, and video monitoring is sometimes included if a parasomnia is suspected.

Type 2: Unattended, comprehensive, portable PSG with a minimum of seven recording channels as per type 1.

Type 3: Modified portable sleep apnoea testing, with a minimum of four recording channels (ECG or heart rate, oxygen saturation, and at least two channels of respiratory movement or respiratory movement and airflow).

Type 4: Continuous recording using one to three recording channels (usually includes pulse oximetry).

In 2007, the Portable Monitoring Task Force of the AASM published clinical guidelines for the use of unattended portable monitors in the diagnosis of OSA based on a review of the literature.[27] It was recommended that unattended, portable monitoring (recording a minimum of airflow, respiratory effort and oximetry) could be used as an alternative to PSG for the diagnosis of OSA in patients with a high pretest probability of moderate-to-severe OSA and without significant medical comorbidities, in conjunction with a comprehensive evaluation by a qualified sleep specialist. It states that portable monitoring devices must allow display of raw data for manual scoring or editing prior to automated analysis, and should be reviewed by a sleep specialist. The guidelines also provide recommendations regarding the acquisition, analysis and interpretation of data, and need for appropriate policies and procedures including a quality improvement programme to assure reliability and validity of testing. Based on these recommendations, the Centres for Medicare and Medicaid Services in the USA have approved the use of a limited home sleep-recording device with at least three channels to diagnose OSA for the purposes of reimbursement for continuous positive airway pressure (CPAP) treatment.

There has been increasing interest in simplified, ambulatory models for diagnosing OSA that combine the use of screening questionnaires and limited sleep monitoring. In a randomised controlled trial (RCT) evaluating an ambulatory management strategy for OSA, Mulgrew *et al*.[28] applied a simplified diagnostic algorithm to identify patients with moderate-severe OSA in a sleep clinic population based on an ESS≥10, SACS≥15 and oxygen desaturation index ≥15/h on overnight home oximetry,

followed by auto-adjusting PAP titration to determine a fixed treatment pressure for ongoing CPAP therapy. Of the patients who scored positively on the diagnostic algorithm and who underwent subsequent PSG, 94% (95% CI 81 to 99%) were correctly identified as having an AHI>15/h. In our own research work, we have evaluated the accuracy of a simplified diagnostic strategy for OSA in a primary care population consisting of the OSA50 questionnaire followed by overnight oximetry.[22] We found that the simple two-step model could identify moderate-severe OSA with a high degree of accuracy, with a sensitivity of 88% and specificity of 82%. In deploying these simplified diagnostic algorithms, it is important to remember that the pretest probability of disease can have a substantial influence on the post-test probability of disease. Thus, ideally, they should be validated within the population of intended application before use or, as a minimum, the pretest probability of disease estimated and taken into account in the interpretation of results. The final test of whether simplified diagnostic algorithms are effective and safe is to determine whether patient outcomes using these methods are the same or similar to those used in more conventional sleep specialist laboratory-based services. Several recent studies have reported encouraging results using such methods, finding non-inferior or non-significant differences for patient outcomes including sleep apnoea symptoms and sleep-related quality of life.[28–33]

NEUROBEHAVIOURAL, CARDIOVASCULAR AND METABOLIC ABNORMALITIES ASSOCIATED WITH OSA

EDS is the cardinal symptom of OSA and is thought to be the main reason for the two–fivefold increased risk of motor vehicle accidents observed among OSA patients.[34] Daytime sleepiness is also a major contributor to the reduced quality of life, mood disturbance, decreased work performance and increased occupational accidents reported by OSA patients. It is important to remember, however, when assessing patients for snoring and possible sleep apnoea, that (1) most subjects identified with OSA in population studies do not report daytime sleepiness[35 36] and (2) there is an extensive list of causes of self-reported sleepiness apart from OSA[37] (eg, depression, lifestyle-related chronic sleep loss, sedating medication and non-respiratory medical comorbidities) which can impact on a patient, and may even be the dominant cause of their sleepiness.

There has been a great deal of interest over the last two to three decades in the possibility that OSA may lead to hypertension, diabetes, hyperlipidaemia, stroke, coronary artery disease and increased mortality.[38] Early data from animal experiments which employed repetitive hypoxia in an attempt to mimic the gas exchange disturbance of OSA showed marked systemic hypertension.[39] Similar experiments have shown derangements in lipid metabolism, including accelerated atherosclerosis, and altered glucose metabolism.[40] Thus, it appears biologically plausible, at least, that a patient with OSA might be at increased risk of cardiovascular and metabolic disease.

Early cross-sectional, population studies suggested that OSA may be a risk factor for hypertension, independent of other known risk factors.[41] However, the results from longitudinal studies have been less convincing. Two studies showed that OSA independently predicted incident hypertension,[42 43] while two other studies did not.[44 45] There have been a relatively large number of small RCTs of CPAP and mandibular advancement therapy[46] for OSA, which have reported the effects on blood pressure. Meta-analyses have shown reductions of approximately 2 mm Hg in both systolic and diastolic blood pressure.[47] A criticism of these earlier studies, and a suggested reason for the small OSA treatment-related reductions in blood pressure was that most patients included in the trials were normotensive. However, similar results have subsequently been reported in RCTs which enrolled newly diagnosed OSA patients with untreated hypertension.[48 49] At the present time, we can conclude that OSA elevates blood pressure, but the effects appear to be relatively modest. Mild pulmonary artery hypertension also appears to be caused by OSA.[50]

While the sustained effects of OSA on blood pressure appear to be quite modest, acute fluctuations in blood pressure at night, secondary to the repetitive obstructed breathing events, episodic hypoxia and hypercapnia and autonomic instability, are relatively large (ie, 10–20 mm Hg). It is possible that these acute OSA-induced physiological changes combined with the increased after-load and stretch placed on the heart during obstructed breathing could lead to acute ischaemic events or arrhythmias during sleep, particularly in individuals with pre-existing cardiac disease.[51] Studies have shown that OSA patients who suffer an acute myocardial infarction, or who die suddenly from cardiac causes, are more likely to do so during the night-time hours than in the morning after rising, as is usually the case.[52 53] Epidemiological evidence suggests that OSA may be an independent risk factor for future strokes, heart failure, atrial fibrillation, ischaemic heart disease and cardiovascular mortality.[54–58] However, the evidence is not consistent between studies, with some studies suggesting that only middle-aged men, and not older men or women, are at risk.[55 56 58]

Small, short-term RCTs conducted in patients with OSA on CPAP therapy have generally shown inconsistent effects on glucose and lipid metabolism.[59] However, a recent well-controlled cross-over RCT of CPAP versus sham CPAP in 75 OSA patients with coexisting metabolic syndrome reported significant improvements in HbA1c, low-density lipoprotein and total cholesterol following OSA treatment.[60]

The field is now in need of definitive large-scale RCTs of OSA treatment that focus on hard cardiovascular outcomes. Several trials are currently in progress, including the multinational Sleep Apnoea cardioVascular Endpoints study.[61]

OSA TREATMENT

A wide range of management options are available for the treatment of OSA ranging from conservative measures including lifestyle modifications to reduce weight and alcohol consumption, to CPAP, mandibular advancement splints (MAS) and surgical interventions. Treatment choices are based on the severity of the patient's OSA, associated symptoms, comorbidities, occupation and patient preferences.

Conservative treatment and lifestyle modifications

Weight loss via dietary modifications and regular exercise should be recommended to all patients with OSA (regardless of severity) who are overweight or obese.[62] Alcohol has been shown to worsen OSA by suppressing protective neuromuscular and arousal reflex responses. Thus, all patients with OSA should be advised to avoid heavy alcohol consumption particularly 4–6 h prior to bed time. In addition, OSA patients appear to exhibit greater decrements in daytime functioning after low-dose alcohol and partial sleep restriction, than non-OSA subjects.[63] They should, therefore, be encouraged to always obtain a full night's sleep, and to limit their alcohol consumption, particularly before undertaking potentially hazardous tasks such as driving.

Supine position-dependent OSA is commonly seen in clinical practice and is found in up to one-third of patients with mild

and moderate OSA.[64] Traditionally, a tennis ball strapped to the back while sleeping has been used to avoid supine sleep. However, studies suggest that long-term compliance with this technique is poor, limiting its effectiveness.[65 66] Newer position monitoring and supine alarm devices may be more comfortable to wear at night. We found in a preliminary study in supine-predominant OSA patients, that one such technique was highly effective in avoiding the supine sleep position and in reducing overnight AHI, although it did not decrease overall snoring intensity.[67]

Continuous positive airway pressure

CPAP is considered the 'gold standard' treatment for OSA. It was first described by Sullivan *et al* in 1981.[68] CPAP consists of a flow generator which delivers air via tubing, and a nasal or oral mask to produce a fixed positive pressure in the upper airway. The PAP splints the upper airway, preventing repeated collapse and closure, stabilises overnight oxygen saturation and reduces sleep fragmentation. Both 'fixed' CPAP and auto-adjusting PAP devices are available. AutoPAP devices automatically adjust PAP to correct obstructive events and compensate for acute changes in posture or long-term changes in weight. They appear to confer no particular clinical advantage over fixed CPAP devices for long-term treatment except perhaps in patients who require a high inflating pressure.[69] However, a short ambulatory study over several nights using an autoPAP device is a useful alternative to an in-laboratory, overnight, manual titration to enable a 'fixed' CPAP level to be estimated to treat OSA.

A systematic meta-analysis of 36 RCTs has shown effectiveness of CPAP in reducing AHI, symptoms of sleepiness and improving quality-of-life measures in people with moderate to severe OSA.[70] The evidence regarding the effect of CPAP on neuropsychological outcomes has been mixed with some RCTs demonstrating improvement in some outcomes,[71] but other studies showing no significant improvement in neurocognitive functioning.[72]

CPAP acceptance and adherence

A significant proportion of patients with moderate to severe OSA reject CPAP treatment outright when it is offered. Cost may be a barrier in some health systems, but even when this is not an issue, initial acceptance can be low. Patients' knowledge and perceptions of the importance of OSA, and the necessity of treatment, appear to be the major determinants of whether or not they accept CPAP therapy. Unfortunately, among those who initially accept CPAP therapy, long-term compliance is also relatively poor. In one study, only 68% of patients were using CPAP after 5 years.[73] Other data suggest that 50% of patients who initiate CPAP discontinue use within the first year, most of them within the first month. Initial acceptance and good long-term compliance are obviously vital in order to obtain the desired benefits from CPAP. Many studies have defined acceptable compliance as consisting of at least 4 h of usage for more than 70% of nights. However, such definitions are arbitrary, and studies show a dose-response curve across a wide range of CPAP average nightly use for outcomes, such as reduced daytime sleepiness.[74] Effort and resources should be dedicated, particularly in the first few weeks of therapy, towards ensuring CPAP acceptance and optimal compliance. Some of the strategies to increase CPAP compliance and adherence are listed in box 2.

Oral appliance therapy

A MAS is the most common oral appliance used as an alternative to CPAP. Other devices include tongue-retaining devices and palatal-lifting devices. A MAS works by advancing the mandible and has been shown to decrease AHI[76] and subjective sleepiness.[77] These devices are usually indicated for patients with mild to moderate OSA who prefer it over CPAP, or who have tried and failed CPAP therapy. MAS devices are generally less effective in reducing the AHI compared with CPAP, and are generally not indicated as a first-line treatment in patients with severe OSA. MAS is contraindicated in some circumstances (box 3).

Box 2

Strategies to maximise continuous positive airway pressure (CPAP) acceptance:

- Education and provision of written literature at an appropriate level for the patient
- Regular weekly phone calls for first few weeks
- Use of nasal humidification

Strategies to improve suboptimal CPAP adherence

- Consideration of cognitive behavioural therapy (CBT) and desensitisation
- Consideration of alternate mask interfaces in case of discomfort or significant leak
- Consideration of a short course of Eszopiclone at CPAP initiation if no contraindications in patients with high risk on non-compliance[75]

Surgical interventions

Surgical interventions are generally not indicated as first-line treatment, and are used only when non-invasive measures have been tried and failed or have been rejected by the patient. Surgical interventions can be broadly divided into procedures aimed at curing OSA via upper airway reconstruction and interventions to improve CPAP adherence, for instance, improving nasal patency by septoplasty or polypectomy. Despite progress and advancements in surgical techniques for the treatment of OSA, there is still a lack of good quality data with regard to the effectiveness and selection of patients for surgical interventions.[78]

Uvulopalatopharyngoplasty (UPPP) is the most common OSA surgical procedure. It involves resection of the uvula, redundant retrolingual soft tissue, and palatine tonsillar tissue. UPPP, with or without tonsillectomy, has not been shown to reliably cure OSA in patients with moderate to severe OSAS.[78] An RCT comparing UPPP and conservative management in OSA patients with >50% obstruction at the palatal level showed improvement in daytime sleepiness and oxygen desaturations at 1 year, however, only 38% achieved normality of their oxygen

Box 3 Relative contraindications for mandibular advancement splints

- Pre-existing temporo-mandibular joint disease or instability
- Insufficient dentition to support device retention, for instance, less than six teeth in each arch
- Severe bruxism
- Patient unable to open the mouth adequately
- Brisk gag reflex

desaturation index at 1 year.[79] The surgical complication rate was 22%. Maxillomandibular advancement (MMA) involves forward-fixing the maxilla and mandible. A meta-analysis which included data from several case series suggested MMA to be more consistent in reducing AHI compared with the other surgical techniques, however, a high risk of bias and the heterogeneity of the studies were limiting factors of this meta-analysis.[80]

There are a variety of procedures to reduce or advance the tongue base. Submucosal radiofrequency, or bipolar techniques, are relatively easy, well tolerated and low risk, but only partially effective for treating sleep apnoea.[81] Hypoglossal nerve stimulation is a new treatment currently under evaluation which leads to contraction of the genioglossus muscle, tongue protrusion, stiffening of the anterior pharyngeal wall and an increase in upper airway diameter. A recent RCT of an implantable hypoglossal nerve stimulation system in 21 patients with moderate to severe OSA who were intolerant of CPAP, showed a success rate (as defined by 50% reduction in AHI with an AHI of <20/h) of 67% at 6 months.[82] This was associated with significant improvement in ESS. However, studies showing benefit in larger patient samples, and after longer periods of follow-up, are required before this therapy can be adopted as part of routine clinical practice.

Other novel therapies currently under evaluation

Acetazolamide has been shown to reduce the respiratory loop gain by approximately 40% in individuals with OSA,[83] however, there is insufficient evidence to recommend its clinical use in patients with OSA at this time. Similarly, eszopiclone has been shown to improve OSA patients with a low arousal threshold,[84] but confirmatory studies are needed to confirm its efficacy and safety. A disposable nasal one-way valve device designed to preferentially increase expiratory airway pressure has recently been shown to reduce AHI and improve subjective sleepiness when compared with sham treatment in patients with mild to severe OSA.[85] However, more long-term data on efficacy, adherence and cost-effectiveness is required before its role in the routine management of OSA can be determined.

OTHER SLEEP-RELATED BREATHING DISORDERS

A detailed discussion of all the sleep-related breathing disorders is beyond the scope of this review, however, a brief note about some of the more relevant conditions which may coexist with OSA is worthwhile. Central sleep apnoea (CSA) is characterised by repetitive, complete cessation of airflow and ventilatory effort during sleep (compared with OSA, in which ventilatory effort persists). CSA may be idiopathic, however, common risk factors include heart failure (usually associated with Cheyne–Stokes respiration (CSR,or crescendo-decrescendo breathing), opiate use and stroke). The mainstay of treatment of CSA is control of the underlying or predisposing risk factor. Positive pressure-mask therapies have also been used. While the intention-to-treat analysis of a multicentre RCT of CPAP therapy for CSR in patients with heart failure was negative with respect to the primary outcome of mortality,[86] CPAP treatment was highly variable in its effect on the sleep-disordered breathing, ranging from virtually no effect to complete suppression of central apnoeas. A posthoc analysis suggested there was clinical benefit in the subset of patients in whom central apnoea was supressed.[86 87] Thus, there is some evidence for the role of CPAP therapy in patients with CSA related to heart failure, but a newer treatment, adaptive servo-controlled ventilation (ASV), a 'smart' form of bilevel positive pressure-mask ventilator support which normalises ventilation by adjusting the level of ventilatory support breath-by-breath, according to the patient's pattern of breathing) may prove, in the long term, to be more effective. Two international, multicentre RCTs of ASV to treat sleep-disordered breathing in patients with heart failure are currently in progress (SERVE-HF (treatment of sleep disordered breathing by adaptive servo-ventilator in heart failure patients), ADVENT-HF (the effect of ASV on survival and frequency of cardiovascular hospital admissions in patients with heart failure and sleep apnea)) Bilevel PAP (BIPAP) with a backup respiratory rate is also an option for treatment of symptoms and/or respiratory failure in patients with CSA related to central nervous system (CNS) suppression (eg, resulting from CNS disease). Complex sleep apnoea refers to a condition in which CSA persists or emerges following the application of CPAP for OSA, This occurs in approximately 10% of patients with OSA,[88] and may be a transitory phenomenon that disappears after several weeks of CPAP treatment.[89] However, in a small proportion of patients, it can persist and limit the effectiveness of therapy. In severe cases, a trial of bilevel pressure support with a backup rate should be considered or, alternatively, ASV. Overlap syndrome refers to the combination of Chronic Obstructive Pulmonary Disease (COPD) and OSA.[90] These patients are at increased risk of hypercapnic respiratory failure and pulmonary hypertension compared with patients who have OSA or COPD alone,[91] and may be at greater risk of COPD exacerbations and premature death.[92] Management should include a trial of CPAP and, in the case of a suboptimal response or worsening respiratory failure, institution of nocturnal BIPAP with or without supplemental oxygen. Sleep-related hypoventilation can occur in the absence of OSA if there is severe mechanical impairment to respiration imposed by morbid obesity or neuromuscular disease and can cause progressive respiratory failure. The reader is directed to several recent reviews which describe the prevalence, pathogenesis and clinical management of this group of disorders.[93 94]

OSA AS A CHRONIC CONDITION AND OSA CHRONIC CARE MODEL

OSA is a common disorder that meets the characteristics of a chronic disease, as it is a disease which is prolonged, does not resolve spontaneously and is rarely completely cured.[95] Thus, OSA requires ongoing management of residual symptoms, deficits and comorbidities. Furthermore, many OSA patients have modifiable lifestyle factors that contribute to their disease, which could be improved with interventions. The recent AASM guideline for OSA shows support for approaching OSA as a chronic disease requiring long-term multidisciplinary management, and this is an important future direction for the care of patients with OSA.[62]

There are a number of common comorbidities seen in OSA patients. Some contribute independently to one of the commonest presenting complaints, EDS, and several have the potential to influence patient outcomes on CPAP.

Obesity is an extremely common and important cause of OSA, as mentioned earlier,[9] and effective therapies for obesity, for instance, bariatric surgery, lead to significant improvements in OSA.[96] Obesity has also been associated with EDS, independent of OSA.[37] Depression is also common among patients with OSA, the reported prevalence being between 21% and 41%.[97] Like obesity, depression may contribute to EDS, independent of OSA. In a population-based study, Bixler and colleagues found that depression was the most significant risk factor for EDS, followed by BMI, age, typical sleep duration, diabetes, smoking and finally, OSA.[37]

Alcohol intake is an important modifiable risk factor for OSA. Alcohol, particularly in the last 2 h before bed-time, increases the duration and frequency of obstructive episodes, and worsens OSA. Other common comorbidities in OSA patients are hypertension, cardiovascular disease and type 2 diabetes mellitus.[98 99]

While CPAP is the gold standard treatment for moderate-severe OSA, some residual symptoms and deficits remain even among those who appear to be optimally treated. We conducted a multicentre study of 174 patients treated with CPAP, and found that 40% of moderate-severe OSA patients still had an abnormal ESS score after 3 months of CPAP treatment.[74] Very similar results were reported by Weaver and colleagues in 2007.[100]

This residual EDS may have various aetiologies, such as disruption to sleep caused by CPAP itself, insufficient use of CPAP, other sleep disorders not responsive to CPAP, coexistent mood disorders, sedating medications, obesity, advanced age, insufficient sleep duration, diabetes, smoking or hypoxic brain injury from chronic OSA. Depression is a particularly important comorbidity to consider when treating OSA, given the overlap between symptoms and the strong association between the two.[37 97] A broader approach to the recognition, diagnosis and management of EDS is warranted, and should be part of chronic condition management in OSA.

The Chronic Care model has been accepted as a conceptual framework to reorganise patient care to meet the needs of people with chronic illness, and is ideal for use in a chronic condition such as OSA.[101] The model is comprised of four components: (1) ongoing self-management support; (2) delivery system features, such as planned visit schedules and multidisciplinary collaborative care arrangements; (3) decision supports, such as guidelines, access to experts and reminder systems and (4) clinical information systems which provide timely data about individual patients and populations. The important role of self-management support in the chronic care model is justified by the recognition that patients themselves and their families are the primary caregivers in chronic illness.[102]

When constructing such a chronic care model, health literacy must be considered. Health literacy includes the ability to read, write and understand health-related information, to make sound health-related decisions, and to navigate life in a way that promotes good health. A recent Australian survey indicated that around 60% of adults lacked the health literacy skills to cope with the demands of modern healthcare, and to make the decisions required to manage their health.[103]

In summary, there are many disease management issues for patients with OSA, including: factors known to contribute to OSA severity and multiple comorbidities, residual daytime sleepiness despite CPAP therapy and inadequate CPAP adherence. All these disease management issues are ideally addressed as part of a comprehensive chronic condition management programme.

It is our view that if Sleep Medicine services focus their therapeutic interventions for OSA solely around devices (CPAP, MAS, etc) and do not incorporate chronic disease management programmes into the care pathways of those with OSA, patient outcomes will remain below expectations.

SUMMARY

Adult OSA is a chronic condition, the prevalence of which is increasing with the increasing trend of obesity and ageing. In addition to obesity, various other anatomical and physiological factors also play a role in the pathogenesis of OSA, including craniofacial features, respiratory control system stability (loop gain), arousal threshold and upper airway dilator muscle activity. Laboratory-based PSG is the gold standard diagnostic test, however, home-based studies could be performed in selected patients with a sleep specialist follow-up. Various models of screening and home-based sleep studies have been proposed and are under investigation. CPAP should be considered as first-line treatment in patients with severe OSA, and, moderate OSA with symptoms. Second-line management options include oral appliances and surgical interventions. Further research has been

Main messages

- In the general population, one in every five persons has an apnoea-hypopnoea index (AHI)>5/h.
- Obesity and increased waist circumference are the most important risk factors for obstructive sleep apnoea (OSA). However, other factors, including craniofacial anatomy, stability of respiratory control centre, upper airway dilator muscle activity are also considered to contribute to the pathogenesis of OSA.
- Various OSA screening tools are increasingly being used to identify people at high risk of OSA in the population.
- In-laboratory polysomnography (PSG) is the current standard for diagnosis of OSA.
- Home-based PSG can be considered as an alternative in selected patients with high pretest probability and without significant comorbidities, in conjunction with a sleep specialist review.
- Untreated OSA is associated with a modest increase in blood pressure, and causes mild pulmonary hypertension.
- OSA has been found to be an independent risk factor for ischaemic heart disease, stroke and overall cardiovascular mortality, particularly in middle-aged men. However, there is a need for good quality treatment intervention studies to see whether OSA treatment can reduce these risks.
- OSA should be managed as a chronic condition with a multidisciplinary approach and involvement of the patient, their family and relevant health professionals.
- Continuous positive airway pressure (CPAP) is the first-line therapy for severe OSA. Oral appliance therapy and surgical interventions can be considered in patients with less severe disease, or in patients who have difficulty tolerating CPAP.
- Treatment and management of coexisting conditions for instance, insomnia and depression is vital for better outcomes.
- Ongoing follow-up with the aim of education, treatment compliance assessment and patient-tailored management are key for successful long-term management of OSA.

Current research questions

- Clearer and more detailed understanding of the various physiologic phenotypes of obstructive sleep apnoea (OSA).
- Long-term relationship between OSA and cardiovascular risk/morbidity.
- Association between OSA and neurocognitive outcomes.
- Feasibility and effectiveness of various new investigative treatments for OSA.

Key references

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undertaken to evaluate potential new treatment modalities, however, data on their effectiveness are currently limited. OSA management should be based on a holistic approach, keeping in mind other comorbidities, and should involve the patient and their family in decision making.

MULTIPLE CHOICE QUESTIONS (TRUE (T)/FALSE (F); ANSWERS AFTER THE REFERENCES)

1. Concerning OSA prevalence and risk factors:

A. OSA is more prevalent in men than in women.
B. OSA is more prevalent among Caucasians than African–Americans.
C. When matched for disease severity Asians will develop OSA at a BMI that is 4 kg/ms/m^2 less than in Caucasians.
D. Weight loss of 10% can reduce the AHI by approximately 26%.
E. Alcohol is an important modifiable risk factor for OSA.

2. The following are symptoms that could be associated with OSA:

A. Fatigue and tiredness
B. Reduced vigilance and executive function
C. Memory impairment
D. Impotence
E. All of the above

3. Regarding the diagnosis of OSA:

A. ECG is not a part of the standard in-laboratory polysomnography.
B. An apnoea is defined as cessation of airflow for at least 10 s.
C. AHI is the number of apnoeas and hypopnoeas per hour of sleep.
D. OSA50 is a validated screening questionnaire based on waist circumference, snoring, witnessed apnoeas and age ≥50.
E. Home-based polysomnography could be an alternative to in-lab study even in complex patients with multiple medical comorbidities.

4. OSA associations and consequences:

A. Drivers with untreated, severe sleep apnoea have a higher chance of automobile crash compared with other drivers.
B. Untreated OSA has not been to be associated with pulmonary hypertension.
C. OSA may be an independent risk factor for systemic hypertension.
D. OSA may be an independent risk factor for heart failure, ischaemic heart disease and cardiovascular mortality.
E. Everyone with OSA can expect to feel excessively sleepy

5. OSA treatment and management:

A. CPAP is the second-line treatment for severe OSA.
B. Self-management support is a critical part of chronic care model for OSA management.
C. Underlying depression should be identified and treated.
D. Alcohol avoidance prior to bed time is usually recommended.
E. Supine avoidance is ineffective and has no role in the management of positional OSA.

Contributors All the authors have contributed towards the manuscript.

Funding None.

Competing interests None.

Provenance and peer review Not commissioned; externally peer reviewed.

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ANSWERS

1. A-T, B-F, C-T, D-T, E-T.
2. A-T, B-T, C-T, D-T, E-T.
3. A-F, B-T, C-T, D-T, E-F.
4. A-T, B-F, C-T, D-T, E-T.
5. A-F, B-T, C-T, D-T, E-F.