

# Sleep apnoea and sleep breathing disorders

***Sleep apnoea and related sleep breathing disorders are a major cause of medical, social and occupational disability. Excessive sleepiness may be associated with respiratory failure, obesity, hypertension and insulin resistance in the cardiometabolic syndrome. This article reviews practical assessment and management.***

**S**leep breathing disorders include the common problems of snoring and obstructive sleep apnoea, and less common central sleep apnoea, upper airways resistance syndrome and obesity hypoventilation syndrome (*Table 1*). Although patients may be asymptomatic, ventilatory failure during sleep and associated sleep fragmentation usually lead to presentation with one or more of a range of problems including snoring, excessive daytime sleepiness, witnessed pauses in breathing and right heart failure (cor pulmonale).

## Clinical presentations

Snoring is generated by the vibration of anatomical structures of the nasopharynx during sleep. Prevalence of habitual snoring ranges from 24–50% in men and from 14–30% in women and increases with age, obesity, alcohol ingestion and nasal obstruction. Snoring results in social disability and relationship disharmony, and has been implicated in the aetiology of hypertension, ischaemic heart disease and cerebrovascular accident as well as increased morbidity and mortality from road traffic and work-related accidents (Jones and Ah-See, 2009).

Obstructive sleep apnoea is a common condition comprising intermittent pauses in breathing during sleep as a result of intermittent complete collapse of the pharyngeal airway, followed by brief arousals or awakenings which then enable return of breathing. The condition may be asymptomatic or present with witnessed snoring and/or pauses in breathing during sleep, excessive daytime sleepiness or a range of non-specific symptoms (*Table 2*). Obstructive sleep apnoea affects up to 4% of

middle-aged men and 2% of middle-aged women in the UK (Scottish Intercollegiate Guidelines Network, 2003). It is detected as absence of nasal airflow with persistence of chest and abdominal respiratory effort.

Obstructive sleep apnoea syndrome is defined as the association of obstructive sleep apnoea with symptoms of excessive sleepiness, or impaired alertness with loss of concentration or memory, as a result of sleep fragmentation (*Table 3*). Only about 1 in 4 people with obstructive sleep apnoea syndrome have been diagnosed and only about half of patients diagnosed have been able to access treatment. Untreated obstructive sleep apnoea syndrome is estimated to cost the NHS £432 million a year. National Institute for Health and Clinical Excellence (NICE, 2008) guidelines and specialist professional bodies support treatment of symptomatic patients based on classification of severity (*Table 4*).

Obstructive sleep apnoea is a major cause of potentially fatal road accidents, lost work productivity, breakdown of personal relationships and impaired quality of life. Patients with excessive sleepiness as a result of obstructive sleep

**Table 1. Sleep breathing disorders**

Snoring
Obstructive sleep apnoea
Central sleep apnoea
Central sleep apnoea and Cheyne–Stokes respiration
Upper airways resistance syndrome
Obesity hypoventilation syndrome

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**Table 2. Obstructive sleep apnoea: clinical presentation**

Common (>60%)	Loud snoring
	Excessive daytime sleepiness
	Feelings of choking or shortness of breath at night
	Restless sleep
	Unrefreshing sleep
	Changes in personality
	Nocturia
Less common (10–60%)	Morning headaches
	Enuresis
	Reduced libido
	Spouse worried by apnoeic pauses
	Nocturnal sweating
	Symptomatic oesophageal reflux
Rare (>10%)	Recurrent arousals or insomnia
	Nocturnal cough

apnoea syndrome are up to seven times more likely to have a road accident, and have a worse simulated driving performance than drivers in excess of the blood alcohol limit (Findley et al, 1988; George et al, 1996). The Scottish Intercollegiate Guidelines Network (2003) guidelines noted an 83% reduction in road traffic accidents in obstructive sleep apnoea syndrome patients on treatment with continuous positive airway pressure. Obstructive sleep apnoea syndrome frequently disrupts personal relationships with effects of sleep loss suffered by both patients and partners including irritability and feeling too tired for sex, leading to misunderstandings and strain. Patients may become impotent and may lose interest in social and family activities. Obstructive sleep apnoea syndrome has been recognized as a community health problem, impairing the quality of life and wellbeing of not only the individual patient, but the entire family and society.

The pathophysiology of obstructive sleep apnoea includes intermittent hypoxia and possibly sympathetic activation which drives an inflammatory cascade with interaction of haemodynamic and inflammatory changes to promote vascular remodelling. Organ, tissue or functional impairment is related to the severity of nocturnal hypoxia (Lévy et al, 2008).

Co-morbidities commonly associated with obstructive sleep apnoea syndrome include hypertension, heart failure, obesity, diabetes mellitus and stroke, often in combination comprising a cardiometabolic syndrome. Insulin resistance may develop in obstructive sleep apnoea syndrome owing to the effect of intermittent hypoxia, and may occur independently of obesity, with prevalence nine times more in subjects with obstructive sleep apnoea syndrome than obese controls (Punjabi et al, 2002; Coughlin et al, 2004). This may help explain the increased morbidity and mortality associated with sleep apnoea, and the significant potential for reduced morbidity and mortality if obstructive sleep apnoea syndrome is treated (Table 5).

Central sleep apnoea is characterized by recurrent episodes of apnoea during sleep as a result of temporary loss of ventilatory effort or ventilatory control instability. This most often occurs in cardiac failure in which periodic breathing of Cheyne–Stokes respiration may be associated with central sleep apnoea. Cheyne–Stokes respiration with central sleep apnoea has an adverse effect on cardiac prognosis and mortality as it is associated with sympathetic activation, ventricular ectopy and atrial fibrillation. Central sleep apnoea may also occur in patients with neurological disorders or autonomic dysfunction, and may occur with obstructive sleep apnoea in patients with nasal obstruction or after treatment with continuous positive airways pressure which reduces  $\text{paCO}_2$  (Lehman et al, 2007).

Upper airway resistance syndrome is a sleep disorder characterized by airway resistance to breathing during sleep, without cessation of breathing. The primary symptoms are similar to obstructive sleep apnoea syndrome and include daytime sleepiness and excessive fatigue as a

result of arousals in sleep associated with respiratory flow limitation and increased negative intrathoracic pressure. Snoring may also be noted.

Obesity hypoventilation syndrome is the combination of obesity (body mass index above  $30 \text{ kg/m}^2$ ) with hypoxia during sleep, and hypercapnia during the day, as a result of hypoventilation (Anonymous, 1999). About a third of all people with morbid obesity (a body mass index over  $40 \text{ kg/m}^2$ ) have elevated carbon dioxide levels in the blood (Mokhlesi and Tulaimat, 2007). Typical clinical features of patients with obesity hypoventilation syndrome include obesity, excessive daytime sleepiness, a plethoric complexion, cyanosis, and evidence of right heart failure including peripheral oedema. Surprisingly, patients may not complain of dyspnoea, despite obvious

**Table 3. Definitions**

Obstructive sleep apnoea	Apnoea: absence of breathing for at least 10 seconds	
	Hypopnoea: 50% reduction in breathing amplitude with at least 3% oxygen desaturation, or 30% reduction in breathing amplitude with at least 4% oxygen desaturation	
Apnoea–hypnoea index (AHI): the hourly rate of apnoeas plus hypopnoeas	AHI < 5 = Normal	
	AHI 5–15 = Mild	
	AHI 16–30 = Moderate	
	AHI > 30 = Severe	
Obstructive sleep apnoea syndrome	> five obstructed breaths/hour and excessive daytime sleepiness not better explained by other factors (or two or more of):	Choking or gasping in sleep
		Recurrent awakenings
		Unrefreshed sleep
		Daytime fatigue
		Impaired concentration

**Table 4. Indications for continuous positive airways pressure in obstructive sleep apnoea syndrome**

Symptomatic severe obstructive sleep apnoea syndrome (AHI > 30)
Symptomatic moderate obstructive sleep apnoea syndrome (AHI > 15)
Mild obstructive sleep apnoea syndrome (AHI 5–15) if: symptoms affect quality of life and ability to go about daily activities and lifestyle advice and any other relevant treatment options have been unsuccessful, or are considered inappropriate
AHI = apnoea hypopnoea index

**Table 5. Obstructive sleep apnoea and co-morbidities**

Resistant hypertension
Nocturnal hypertension
Stroke
Coronary artery disease
Recurrent atrial fibrillation
Nocturnal bradycardias
Type 2 diabetes mellitus

hypoxaemia. Many people with obesity hypoventilation syndrome will also have obstructive sleep apnoea syndrome as an overlap syndrome. Alternative explanations for hypoventilation must be excluded such as use of narcotics, severe obstructive or interstitial lung disease, severe chest wall disorders such as kyphoscoliosis, severe hypothyroidism, neuromuscular disease or congenital central hypoventilation syndrome.

Overlap syndromes are not uncommon, in which obstructive sleep apnoea co-exists with other sleep breathing disorders causing ventilatory failure and excessive sleepiness, including obesity hypoventilation syndrome and chronic obstructive pulmonary disease. Obstructive sleep apnoea may also co-exist with narcolepsy, and may be a trigger for non-respiratory sleep disorders including sleep-walking and parasomnias.

**Diagnosis**

A structured history and assessment, and screening of patients with common co-morbidities will identify people with high probability for sleep breathing disorders. General population surveys have found a strong correlation between snoring and daytime sleepiness. Early clues to a diagnosis of obstructive sleep apnoea syndrome include excessive or intrusive sleepiness associated with snoring and/or witnessed pauses (apnoeas) or choking during sleep. The Epworth sleepiness scale score is a validated simple self-administered assessment tool, but low scores do not exclude sleepiness (*Figure 1*) (Johns, 1991). Reporting of apnoea by the bed partner is more predictive of sleep apnoea than snoring alone. Less common symptoms include nocturnal urinary frequency, morning headaches and impotence (*Table 2*).

Obstructive sleep apnoea may develop in endocrine disease including hypothyroidism, diabetes mellitus

(autonomic dysfunction) and acromegaly, and in neurological conditions including Parkinson’s disease. Anaesthetic guidelines (The Association of Anaesthetists of Great Britain and Ireland, 2007) advise screening of obese patients before general anaesthesia and surgery.

Examination may reveal obesity (in 70% of patients with obstructive sleep apnoea), with increased neck and waist circumference and body mass index. Some patients may have nasal airway obstruction (deviated nasal septum, rhinitis or polyps), or enlarged soft palate, tonsils or uvula. Signs of cor pulmonale may occasionally be present including ankle swelling.

Confirmation of diagnosis, treatment, and monitoring of treatment response in obstructive sleep apnoea syndrome and other sleep breathing disorders should be carried out in a specialist sleep service by appropriately trained medical and support staff.

**Investigations**

Overnight oximetry can be undertaken at home in conjunction with clinical assessment. In obstructive sleep apnoea, a typical oximetry pattern shows a normal baseline oxygen saturation with intermittent dips and 4% oxygen desaturation index of more than 10 per hour, with heart rate fluctuation. Overnight oximetry is relatively specific but insensitive for obstructive sleep apnoea, such that absence or relative paucity of oximetry dips does not exclude sleep apnoea, and is not uncommon in symptomatic obstructive sleep apnoea patients with frequent apnoeas or hypopnoeas and consequent arousals producing sleep fragmentation. Gated video recording may be used in conjunction with oximetry to detect sleep arousals. A low baseline saturation suggests other causes of respiratory failure including obesity hypoventilation syndrome and chronic obstructive pulmonary disease which may be concurrent with obstructive sleep apnoea (overlap syndromes) (*Figure 2*). Oxygen desaturation may occur as a result of other respiratory and cardiac disorders and expert interpretation is essential. A more detailed sleep study (polysomnography) is generally required unless oximetry shows a typical pattern in a patient with typical presentation.

Respiratory polysomnography allows diagnosis of sleep apnoea, classification and assessment of severity in most patients with typical obstructive sleep apnoea. This limited multi-channel portable monitoring may be provided in a home or inpatient setting by specialist sleep and respiratory services. In addition to oximetry, the test uses nasal airflow, chest and abdominal sensors to measure respiration, producing an apnoea–hypopnoea index (*Figure 3, Table 3*). In upper airways resistance syndrome apnoeas and hypopnoeas are absent or present in low numbers, but a diagnosis can be made using a nasal cannula and pressure transducer to measure inspiratory airflow limitation.

Full polysomnography may be required in complex sleep disorders including cases of possible obstructive sleep apnoea which may overlap with co-morbidities

**Figure 1. Epworth sleepiness scale score. A score of more than 10 indicates significant sleepiness.**

How likely are you to doze off or fall asleep in the following situations, in contrast to feeling just tired? This refers to your usual way of life in recent times. Even if you have not done some of these things recently try to work out how they would have affected you.

Use the following scale to choose the most appropriate number for each situation: 0 = no chance of dozing, 1 = slight chance of dozing, 2 = moderate chance of dozing, 3 = high chance of dozing

Situation	Chance of dozing
Sitting and reading	
Watching TV	
Sitting inactive in a public place (e.g. a theatre or a meeting)	
As a passenger in a car for an hour without a break	
Lying down to rest in the afternoon when circumstances permit	
Sitting and talking to someone	
Sitting quietly after a lunch without alcohol	
In a car, while stopped for a few minutes in traffic	
<b>Total</b>	

including cardiac failure, chronic obstructive pulmonary disease, upper airway resistance and obesity hypoventilation syndrome, or with other causes of excessive sleepiness and sleep disorders including periodic limb movement and narcolepsy. Polysomnography includes electroencephalogram sleep staging and video and is usually carried out by specialist sleep services in a tertiary regional setting. Full polysomnography may help to differentiate obstructive sleep apnoea from nocturnal epilepsy, and may demonstrate obstructive sleep apnoea as a trigger in patients presenting with sleepwalking or other sleep behavioural disorders (parasomnias). In upper airways resistance syndrome, multiple snore arousals may be seen, with progressive elevation of oesophageal pressure fluctuations terminating in arousals if an oesophageal probe is used.

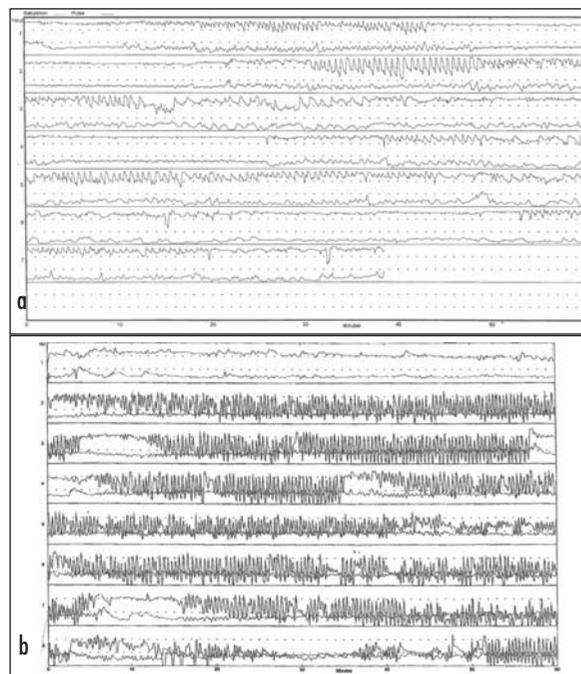
**Treatment**

General measures for treatment of sleep breathing disorders include behavioural modification and lifestyle advice comprising weight control, elevation of the bed head, treatment of nasal congestion and avoidance of supine posture, alcohol, sedatives and narcotics. Scottish Intercollegiate Guidelines Network (2003) guidelines advise good sleep hygiene with 7–8 hours in a quiet dark bedroom, and avoidance of daytime naps. Driving should be avoided if excessively sleepy. Motor vehicle drivers with obstructive sleep apnoea who have ‘excessive or unavoidable sleepiness in inappropriate situations’ (obstructive sleep apnoea syndrome) must inform the Driving and Vehicle Licencing Authority (via form SL-1) and motor insurers of their diagnosis, and may be allowed to drive if symptoms are controlled on treatment, with confirmation by medical opinion.

**Continuous positive airways pressure**

Continuous positive airways pressure is a clinically proven and cost-effective treatment for moderate to severe obstructive sleep apnoea syndrome and corrects excessive daytime sleepiness in most patients (Engleman et al, 1994). It involves delivery of pressurized air from an electric compressor to the nose or mouth via a mask or nasal cushion interface (Figure 4). NICE guidance on continuous positive airways pressure treatment in obstructive sleep apnoea syndrome confirms benefits which include clearer thinking and concentration, improved snoring and pauses in sleep, better daytime function and improved psychological wellbeing (Table 6). Continuous positive airways pressure treatment can reduce blood pressure and may reduce cardiac risk by 20% and risk of stroke by 40% over a 5–10-year period.

Quality of life benefits of continuous positive airways pressure treatment of obstructive sleep apnoea syndrome include an average lifetime gain of 5.4–8 quality added life years, at a cost below £5000 per quality added life year gained, a 24% increase in health status and very favourable cost utility ratio. It remains unclear if continuous positive airways pressure has cardiovascular benefits

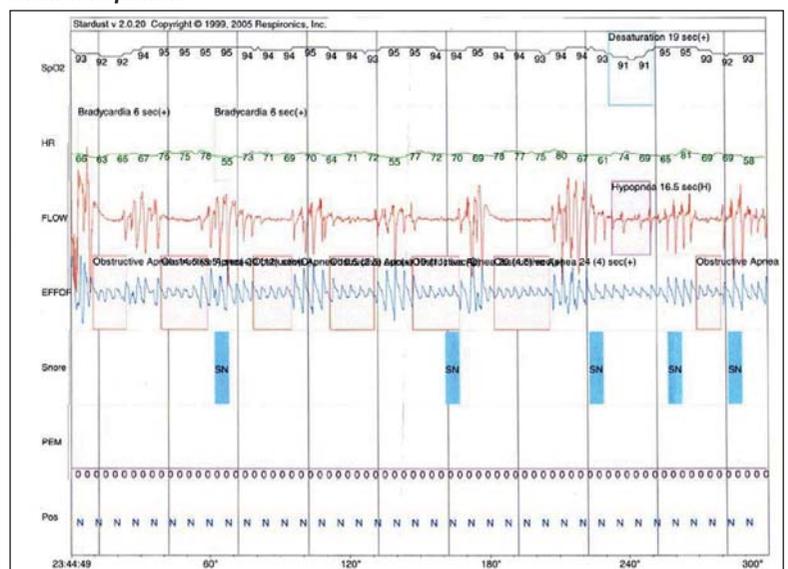


**Figure 2. a.** Overnight oximetry in obstructive sleep apnoea. Frequent falls in oxygen saturation of more than 4% but normal baseline oxygen saturation. **b.** Overnight oximetry in obstructive sleep apnoea with obesity hypoventilation (overlap syndrome). Frequent falls in oxygen saturation of more than 4% but low baseline oxygen saturation.

in asymptomatic patients or only in those with excessive sleepiness (Barbe et al, 2001; Robinson et al, 2006; Bradley and Floras, 2009).

NICE (2008) guidance recommends continuous positive airways pressure as a treatment option for adults with symptomatic moderate (apnoea–hypopnoea index >15) or severe (apnoea–hypopnoea index >30) obstructive sleep apnoea syndrome. Continuous positive airways pressure is recommended for adults with mild obstructive sleep apnoea syndrome (apnoea–hypopnoea index 5–15) if they have symptoms that affect their quality of life and ability to go about their daily activities and lifestyle

**Figure 3. Respiratory polysomnography report. Episodic cessation of nasal airflow (FLOW) is associated with continued thoracic respiration (EFFORT) and is followed by a transient fall in oxygen saturation (SpO2). Heart rate (HR) slows following apnoea and increases after return of respiration.**



advice and any other relevant treatment options have been unsuccessful or are considered inappropriate (Table 3). Continuous positive airways pressure has been used with uncertain long-term benefit in patients with central sleep apnoea and heart failure (Cheyne–Stokes respiration with central sleep apnoea) (Bradley et al, 2005).

Continuous positive airways pressure titration allows optimum pressure adjustment either overnight in hospital or preferably during a 1- or 2-week home trial, which allows better assessment of improvement in sleepiness and quality of life, as well as compliance. Pressure titration may be carried out equally effectively by manual adjustment, auto-titrating continuous positive airways pressure equipment, or by a calculated algorithm based on neck circumference and body mass index (Morgenthaler et al, 2008). Patients with obstructive sleep apnoea syndrome should aim to use continuous positive airways pressure for as much of the night as possible and preferably for 6 hours (Campos-Rodriguez et al, 2005).

Continuous positive airways pressure compliance at 5 years is 68%, and predicted by use at 3 months, snoring history, apnoea–hypopnoea index  $\geq 30$  and Epworth sleepiness scale score of 10 or more. Common problems leading to poor continuous positive airways pressure adherence or compliance include mask leak or discomfort, nasal congestion, dryness and rhinorrhoea. Heated humidification of continuous positive airways pressure and/or use of a nasal steroid may be helpful for nasal problems (Kushida et al, 2006). Ear, nose and throat assessment is advised in patients with symptomatic nasal obstruction, as correction of obstruction caused by a deviated nasal septum or polyps may be a useful adjunct to

continuous positive airways pressure therapy (Sundaram et al, 2005). Claustrophobia or difficulty in exhalation may require education and possible adjustment of the mask interface or air pressure. Education is more effective than change of interfaces (Ballard et al, 2007). Pneumocephalus and epistaxis are uncommon problems.

Persistent daytime sleepiness may occur despite adequate continuous positive airways pressure and good sleep hygiene in about 15% of treated obstructive sleep apnoea syndrome patients, but this is no higher than in a general community with the usual lifestyle reasons for sleepiness as well as any undiagnosed sleep disorders (Stradling et al, 2007). In these cases clinical review should be undertaken to confirm the diagnosis of obstructive sleep apnoea syndrome, to check continuous positive airways pressure interface, compliance and titration, and to exclude associated co-morbid conditions such as poor sleep hygiene, depression, narcolepsy or idiopathic hypersomnia. If necessary, a full polysomnography followed by a multiple sleep latency test or even a full polysomnography with continuous positive airways pressure titration should be performed (Santamaria et al, 2007). Modafinil is licensed as an alerting drug for the management of residual excessive sleepiness in patients with obstructive sleep apnoea syndrome on nasal continuous positive airways pressure, and is used after adequate continuous positive airways pressure therapy has been confirmed by repeated titration. Continuous positive airways pressure use should not be reduced, and careful adherence monitoring is required (Kingshott et al, 2001; Schwartz et al, 2003).

Complex continuous positive airways pressure therapy modalities include C-flex or Bi-flex which allow end-expiratory pressure relief, and auto-titrating airway pressure which provides continuous rather than fixed pressure therapy according to airflow. These have no clear advantage in continuous positive airways pressure-naïve patients with obstructive sleep apnoea syndrome, but may be used in unusual situations including persistent expiratory discomfort or mouth leak, or if high pressures are required in patients with obstructive sleep apnoea syndrome or obesity hypoventilation syndrome. Auto-titrating airway pressure is not advised for diagnosis of obstructive sleep apnoea syndrome, and is not advised for treatment in non-snoring patients, in split-night continuous positive airways pressure titration, or in patients with chronic obstructive pulmonary disease, central sleep apnoea, chronic heart failure or hypoventilation (Morgenthaler et al, 2008).

Bi-level non-invasive ventilation may be required in obstructive sleep apnoea patients requiring high pressures (Reeves-Hoche et al, 1995), or those with persistent ventilatory failure despite continuous positive airways pressure, for example in patients with chronic obstructive pulmonary disease or obesity hypoventilation syndrome amounting to overlap syndromes (Piper et al, 2008). Bi-level non-invasive ventilation with adjustable volume and pressure support may be helpful in these patients to ensure

**Figure 4. Treatment with continuous positive airways pressure.**



**Table 6. Benefits of continuous positive airways pressure in obstructive sleep apnoea**

Improved sleepiness
Clearer thinking and concentration
Improved snoring and pauses in sleep
Better daytime function
Improved psychological wellbeing
Better quality of life

an adequate tidal volume. Bi-level non-invasive ventilation may also be useful in patients in whom obstructive sleep apnoea is mixed with a substantial amount of central sleep apnoea that has not responded to simpler therapies including overnight oxygen or acetazolamide. Central sleep apnoea may emerge in patients treated by continuous positive airways pressure, possibly following initial over-titration of continuous positive airways pressure (Lehman et al, 2007). This may resolve on continued fixed pressure continuous positive airways pressure over 3 months, but adaptive servo pressure support ventilation may be helpful used in such cases (Arzt et al, 2009).

### Surgical management

Surgical options for snoring and mild obstructive sleep apnoea include oral appliance therapy and naso-pharyngeal surgery in combination with lifestyle measures. Oral appliance therapy (dental appliances or mandibular advancement splints) may be used for the treatment of snoring and obstructive sleep apnoea. Appliances are worn during sleep to maintain the patency of the upper airway by increasing its dimensions and reducing collapsibility. Oral appliance therapy may be a first-line option for snoring in patients with or without mild obstructive sleep apnoea, or in patients expressing a preference for it. Oral appliance therapy is a second-line therapy for patients with obstructive sleep apnoea syndrome who fail to benefit from or discontinue continuous positive airways pressure therapy (Lim et al, 2008). Oral appliances improve polysomnographic indices of obstructive sleep apnoea, subjective and objective measures of sleepiness, blood pressure, neuropsychological functioning and quality of life. Oral appliances are often preferred by patients, with the potential for better patient adherence and equivalent health outcome (Lim et al, 2008).

Nasal surgery may be considered to overcome any anatomical obstruction, including septoplasty, submucous diathermy to inferior turbinates, trimming of inferior turbinates or any combination of these, and adenoidectomy (especially in children), following medical treatment of rhinosinusitis if appropriate (Jones and Ah-See, 2009).

Palatal surgery options for snoring include uvulopalatopharyngoplasty, laser-assisted uvulopalatoplasty, and palatal stiffening and shortening techniques. In snoring, evidence for palatal radiofrequency ablation is limited and long-term outcomes are uncertain, with potential risks of haemorrhage, secondary infection and palatal ulceration (NICE, 2005). Soft-palate implants should be used only in the context of research in snoring, and not in obstructive sleep apnoea, because there is a lack of well-controlled and comparative data (NICE, 2007a,b). In obstructive sleep apnoea, results of surgery are disappointing for outcomes of apnoea-hypopnoea index, somnolence and quality of life (Sundaram et al, 2005; NICE, 2007a). Maxillo-mandibular advancement has been investigated only in uncontrolled studies, but surgery might be an option for patients who refuse continu-

ous positive airways pressure or oral devices and have craniofacial abnormalities. Randomized controlled trials are therefore required. Bariatric surgery to aid weight loss is effective in reducing obstructive sleep apnoea, and also reduces the severity of co-morbidities (Haines et al, 2007). There is, however, a high incidence of persistent sleep apnoea, snoring, and discontinuation of continuous positive airways pressure after 1 year, related to initial obstructive sleep apnoea severity (Lettieri et al, 2008).

### Conclusions

Sleep apnoea and other sleep breathing disorders are common causes of morbidity and mortality, affecting the population beyond those with the condition. Effective treatment for obstructive sleep apnoea syndrome with continuous positive airways pressure is relatively simple and cost-effective, but the condition is often unrecognized, and demand for treatment outstrips provision. There is an urgent need to develop greater diagnostic and therapeutic capacity to meet this need. Large-scale randomized trials are needed to determine whether treating obstructive sleep apnoea improves cardiovascular outcomes. **BJHM**

*Conflict of interest: none.*

- Anonymous (1999) Sleep-related breathing disorders in adults: recommendations for syndrome definition and measurement techniques in clinical research. The Report of an American Academy of Sleep Medicine Task Force. *Sleep* **22**(5): 667–89
- Arzt M, Schulz M, Schroll S et al (2009) Time course of continuous positive airway pressure effects on central sleep apnoea in patients with chronic heart failure. *J Sleep Res* **18**(1): 20–5
- Ballard RD, Gay PC, Strollo PJ (2007) Interventions to improve compliance in sleep apnea patients previously non-compliant with continuous positive airway pressure. *J Clin Sleep Med* **3**(7): 706–12
- Barbe F, Mayorals LR, Duran J et al (2001) Treatment with continuous positive airway pressure is not effective in patients with sleep apnea but no daytime sleepiness. A randomized, controlled trial. *Ann Intern Med* **134**: 1015–23
- Bradley TD, Logan AG, Kimoff RJ et al (2005) Continuous positive airway pressure for central sleep apnea and heart failure. *N Engl J Med* **353**: 2025–33
- Bradley TD, Floras JS (2009) Obstructive sleep apnoea and its cardiovascular consequences. *Lancet* **373**: 82–93
- Campos-Rodriguez F, Pena-Grinan N, Reyes-Nunez N et al (2005) Mortality in obstructive sleep apnea-hypopnea patients treated with positive airway pressure. *Chest* **128**: 624–33
- Coughlin SR, Mawdsley M, Mugarza JA, Calverley PMAC, Wilding JPH (2004) Obstructive sleep apnoea is independently associated with an increased prevalence of metabolic syndrome. *Eur Heart J* **25**(9): 735–41

### KEY POINTS

- Sleep apnoea and related sleep breathing disorders are common causes of medical, social and occupational disability and mortality.
- Excessive sleepiness and respiratory failure may be associated with obesity, hypertension and insulin resistance in the cardio-metabolic syndrome.
- Continuous positive airways pressure is a clinically proven and cost-effective treatment for moderate to severe obstructive sleep apnoea syndrome.
- Oral appliances improve snoring and mild to moderate obstructive sleep apnoea.
- Results of surgery are disappointing in the treatment of sleep breathing disorders.

- Engleman HM, Martin SE, Deary IJ, Douglas NJ (1994) Effect of continuous positive airway pressure treatment on daytime function in sleep apnoea/hypopnoea syndrome. *Lancet* **343**: 572–5
- Findley LJ, Unverzagt ME, Suratt PM (1988) Automobile accidents involving patients with obstructive sleep apnoea. *Am Rev Respir Dis* **138**: 337–40
- George CF, Boudreau AC, Smiley A (1996) Simulated driving performance in patients with obstructive sleep apnoea. *Am J Respir Crit Care Med* **154**(1): 175–8
- Haines KL, Nelson LG, Gonzalez R et al (2007) Objective evidence that bariatric surgery improves obesity-related obstructive sleep apnea. *Surgery* **141**(3): 354–8
- Johns MW (1991) A new method for measuring daytime sleepiness: the Epworth Sleepiness Scale. *Sleep* **14**(6): 540–5
- Jones T, Ah-See K (2009) Surgical and non-surgical interventions used primarily for snoring (Protocol). *Cochrane Database Syst Rev* **2**: CD003028
- Kingshott RN, Vennelle M, Coleman EL et al (2001) Randomized, double-blind, placebo-controlled crossover trial of modafinil in the treatment of residual excessive daytime sleepiness in the sleep apnoea/hypopnea syndrome. *Am J Respir Crit Care Med* **163**(4): 918–23
- Kushida CA, Littner MR, Hirshkowitz M et al (2006) Practice parameters for the use of continuous and bilevel positive airway pressure devices to treat adult patients with sleep-related breathing disorders. *Sleep* **29**: 375–80
- Lehman S, Antic NA, Thompson C, Catcheside PG, Mercer J, McEvoy RD (2007) Central sleep apnea on commencement of continuous positive airway pressure in patients with a primary diagnosis of obstructive sleep apnea-hypopnea. *Clin Sleep Med* **3**(5): 462–6
- Lettieri CJ, Eliasson AH, Greenburg DL (2008) Persistence of obstructive sleep apnea after surgical weight loss. *J Clin Sleep Med* **4**: 333–8
- Lévy P, Pepin JL, Arnaud C et al (2008) Intermittent hypoxia and sleep-disordered breathing: current concepts and perspective. *Eur Respir J* **32**: 1082–95
- Lim J, Lasserson TJ, Fleetham J, Wright J (2008) Oral appliances for obstructive sleep apnoea. *Cochrane Database Syst Rev* **4**
- Mokhlesi B, Tulaimat A (2007) Recent advances in obesity hypoventilation syndrome. *Chest* **132**(4): 1322–36
- Morgenthaler TI, Aurora RN, Brown T et al (2008) Practice parameters for the use of autotitrating continuous positive airway pressure devices for titrating pressures and treating adult patients with obstructive sleep apnea syndrome: an update for 2007. An American Academy of Sleep Medicine report. *Sleep* **31**(1): 141–7
- National Institute for Clinical Excellence (NICE) (2005) *Radiofrequency ablation of the soft palate for snoring*. Interventional procedure guidance 124. National Institute for Clinical Excellence, London ([www.nice.org.uk/Guidance/IPG124](http://www.nice.org.uk/Guidance/IPG124) accessed 29 May 2009)
- National Institute for Health and Clinical Excellence (NICE) (2007a) *Soft-palate implants for simple snoring*. Interventional procedure guidance 240. National Institute for Health and Clinical Excellence, London ([www.nice.org.uk/Guidance/IPG240](http://www.nice.org.uk/Guidance/IPG240) accessed 29 May 2009)
- National Institute for Health and Clinical Excellence (NICE) (2007b) *Soft-palate implants for obstructive sleep apnoea*. Interventional procedure guidance 241. National Institute for Health and Clinical Excellence, London ([www.nice.org.uk/Guidance/IPG241](http://www.nice.org.uk/Guidance/IPG241) accessed 29 May 2009)
- National Institute for Health and Clinical Excellence (NICE) (2008) *Guidance on sleep apnoea and continuous positive airways pressure (CPAP)*. NICE technology appraisal guidance 139. National Institute for Health and Clinical Excellence, London ([www.nice.org.uk/Guidance/TA139](http://www.nice.org.uk/Guidance/TA139) accessed 29 May 2009)
- Piper AJ, Wang D, Yee BJ, Barnes DJ, Grunstein RR (2008) Randomised trial of CPAP vs bilevel support in the treatment of obesity hypoventilation syndrome without severe nocturnal desaturation. *Thorax* **63**(5): 395–401
- Punjabi NM, Sorkin JD, Katzell LI, Goldberg AP, Schwartz AR, Smith PL (2002) Sleep-disordered breathing and insulin resistance in middle-aged and overweight men. *Am J Respir Crit Care Med* **165**: 677–82
- Reeves-Hoche MK, Hudgel DW, Meck R, Wittman R, Ross A, Zwillich CW (1995) Continuous versus bilevel positive airway pressure for obstructive sleep apnea. *Am J Respir Crit Care Med* **151**: 443–9
- Robinson GV, Smith DM, Langford BA, Davies RJO, Stradling JR (2006) Continuous positive airway pressure does not reduce blood pressure in non-sleepy hypertensive OSA patients. *Eur Respir J* **27**: 1229–35
- Santamaria J, Iranzo A, Ma Montserrat J, de Pablo J (2007) Persistent sleepiness in CPAP treated obstructive sleep apnea patients: evaluation and treatment. *Sleep Med Rev* **11**: 195–207
- Schwartz JR, Hirshkowitz M, Erman MK, Schmidt-Nowara W (2003) Modafinil as adjunct therapy for daytime sleepiness in obstructive sleep apnea. *Chest* **124**(6): 2192–9
- Scottish Intercollegiate Guidelines Network (SIGN) (2003) *Management of Obstructive Sleep Apnoea/Hypopnoea Syndrome in Adults*. Scottish Intercollegiate Guidelines Network, Edinburgh
- Stradling JR, Smith D, Crosby J (2007) Post-CPAP sleepiness - a specific syndrome? *Sleep Res* **16**: 436–8
- Sundaram S, Bridgman S, Lim J, Lasserson TJ (2005) Surgery for obstructive sleep apnoea. *Cochrane Database Syst Rev* (4): CD001004
- The Association of Anaesthetists of Great Britain and Ireland (2007) *Peri-operative Management of Morbidly Obese Patient*. The Association of Anaesthetists of Great Britain and Ireland, London

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