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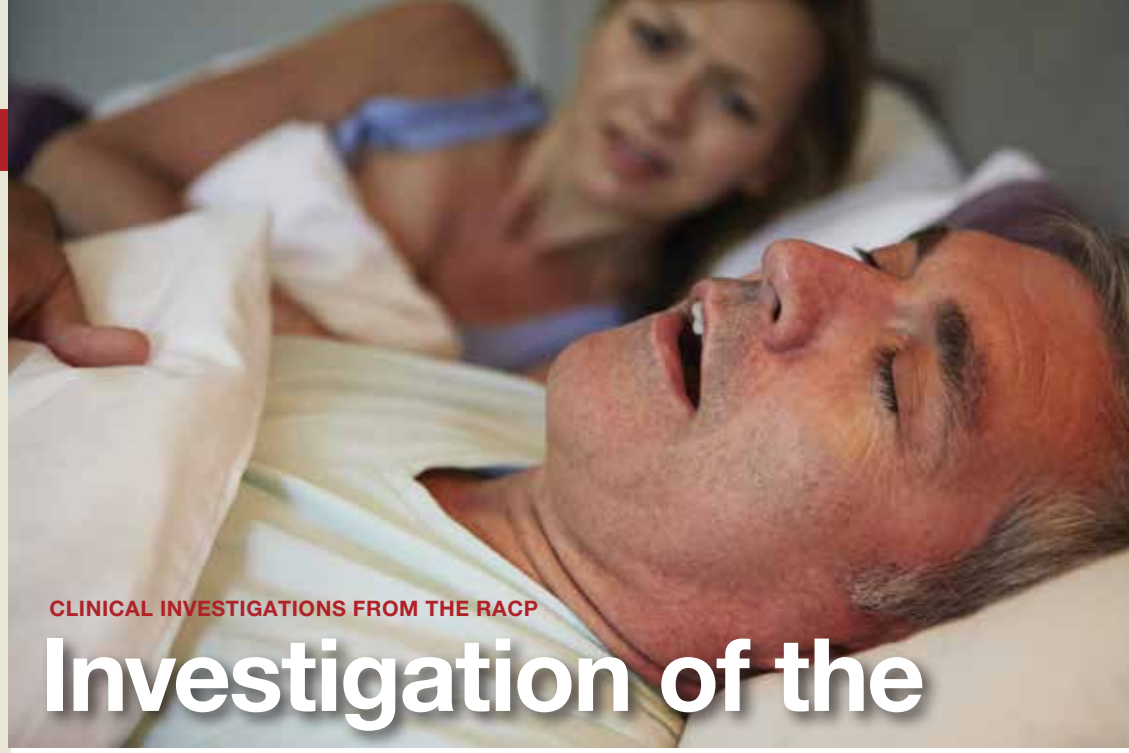

CLINICAL INVESTIGATIONS FROM THE RACP

Investigation of the snoring patient

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In this series, we present authoritative advice on the investigation of a common clinical problem, especially commissioned for family doctors and written by members of the Royal Australasian College of Physicians.

Key points

- **Snoring that is socially disturbing or associated with cardiovascular disease, daytime sleepiness or imminent major surgery is worthy of investigation.**
- **Investigations depend on the severity of the patient's condition, treatment planned and clinician experience.**
- **Assessment should start with a thorough history and examination, in particular seeking symptoms and risk factors for obstructive sleep apnoea (OSA).**
- **Simple screening questionnaires can help determine OSA risk and identify snorers who require further investigation.**
- **Investigations range from simple overnight oximetry in the patient's home to detailed polysomnography in a sleep laboratory.**
- **Treatment includes conservative, dental and surgical options and continuous positive airway pressure.**

Snoring is the sound generated by the collapsible oropharynx in response to sleep-related loss of muscle tone. Snoring can be associated with obstructive sleep apnoea (OSA) and is regarded by many sleep specialists as a cardiovascular risk factor on a par with smoking.

Factors that predispose to snoring are shown in Figure 1. Snoring can occur at any age from about 2 years, when the epiglottis and soft palate developmentally separate in preparation for speech to occur. Although intermittent light snoring ('noisy breathing') is very common in middle age, chronic or habitual snoring occurs in at least 28% of women and 44% of men aged between 30 and 70 years.[1] Snoring intensity correlates with the severity of OSA, albeit weakly.[2,3]

OSA is defined as collapse of the oropharynx for 10 seconds or longer (sometimes up to around 90 seconds) associated with either hypoxaemia or arousal from sleep. Partial upper airway collapse of a similar duration, also associated with hypoxaemia or sleep arousal, is termed hypopnoea.

The gold standard objective metric used to assess OSA is the frequency of apnoea and hypopnoea episodes per hour of sleep measured during polysomnography, termed the apnoea hypopnoea index (AHI). Other measurements used for OSA include the respiratory disturbance index (RDI), which defines hypopnoea more liberally (as a reduction in airflow with arousal but no hypoxaemia), and the oxygen dip index (ODI), in which dips in oxygen saturation on continuous oximetry are measured per hour of

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recording time (i.e. not sleep time).

In adults, OSA is defined as an AHI of five or more events per hour (eph), with levels up to around 120 eph having been observed. OSA is categorised as:

- mild (5 to less than 15 eph)
- moderate (15 to less than 30 eph)
- severe (30 or more eph).

The OSA 'syndrome' is defined as OSA that is causing symptoms (see Box 1).

Snoring and OSA are influenced by sleep state as follows.

- Stages 1 and 2 non-REM sleep are characterised by soft snoring and 'periodic' breathing (defined by gentle waxing and waning of ventilation, sometimes associated with periods of central apnoea)
- Slow-wave sleep is characterised by long periods of continuous loud snoring
- REM sleep is characterised by irregular bursts of snoring with long episodes of apnoea and significant hypoxaemia.

EPIDEMIOLOGY

The estimated prevalence of OSA (AHI more than 5 eph) in adults in the USA in 1993 was 9% in men and 24% in women, whereas in 2013 it had increased to 25% and 33%, respectively.[1] This significant increase in prevalence over 20 years has been attributed to population-based weight gain, but other factors are likely to have contributed, such as increasing age, coexistent medical problems (such as those associated with fluid retention), sleep deprivation and use of drugs that aggravate OSA (e.g. narcotics, steroids and antiseizure medications). Australian prevalence is thought to be similar to that in the USA.

The sex difference in snoring and OSA probably relates to men having a longer oropharynx, stronger inspiratory muscle strength and more centrally distributed obesity.

CLINICAL PRESENTATION

Patients with suspected OSA who seek healthcare assistance generally fall into one of four groups. First is the group in which 'noise pollution' is unbearable to others. This proxy symptom, although often a topic for dinner table laughter, is a serious concern, particularly when relationships are beginning to weaken.

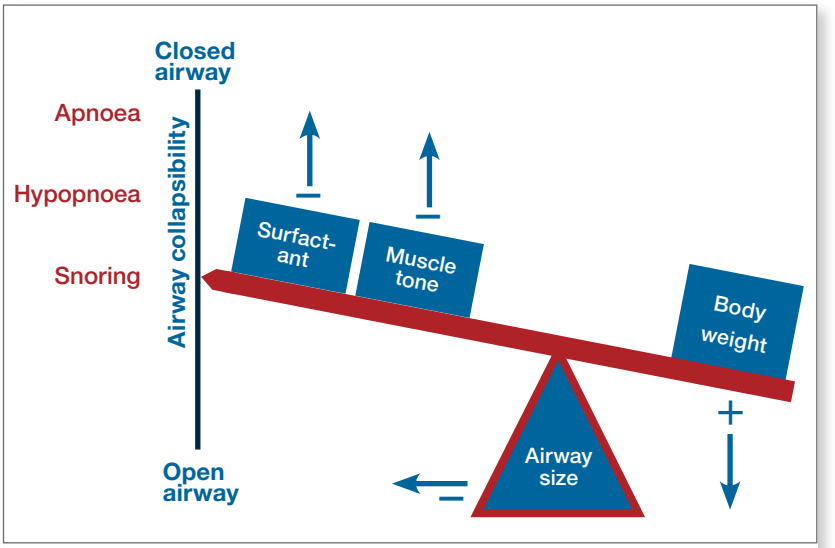


Figure 1. Schematic representation of factors that predispose to snoring and sleep apnoea. Body weight, upper airway muscle tone, surfactant (moisture) in the upper airway and anatomic airway size influence the position of the pointer (red arrow) on the airway collapsibility scale. As weight increases or muscle tone or surfactant decrease, the pointer rises making snoring and apnoea more likely. (Surfactant in the upper airway usually increases surface tension, preventing collapse of the pharynx; this helps explain why a dry mouth caused by oral breathing can contribute to snoring.) If the airway is small (e.g. retrognathia or enlarged tonsils), the fulcrum shifts to the left, also increasing the chance of snoring and apnoea.

The second group are snorers who have cardiovascular disease that is difficult to control. Examples include difficult to control hypertension (e.g. requiring treatment with more than two antihypertensive drugs), heart failure, paroxysmal atrial fibrillation, orthopnoea, paroxysmal nocturnal dyspnoea or stroke. People with type 2 diabetes often have coexistent OSA; the frequency is so high that it has been proposed that the metabolic syndrome ('syndrome X') be renamed 'syndrome Z'.[4]

The third group are patients who present with daytime sleepiness. Importantly, other causes of daytime sleepiness need to be excluded, such as insufficient sleep duration, shift work, medication side effects and mental health disorders. These disorders can overlap, as exemplified by a recent analysis of around 300 patients attending our sleep clinic with snoring, 50% of whom had objective evidence of depression or anxiety.[5]

The final group are those in whom a dentist or anaesthetist has concerns about OSA based

1. SYMPTOMS OF OBSTRUCTIVE SLEEP APNOEA

- Loud habitual snoring noted by partners, especially when it:
  - is audible in other rooms
  - necessitates bed partners sleeping in a separate room
  - is not abolished by change in sleeping position
  - is independent of alcohol
  - includes witnessed apnoea episodes
- Choking
- Excessive daytime sleepiness especially when:
  - it occurs despite seven or more hours in bed per night
  - patient is unable to remain alert during 'passive' situations (e.g. meetings, driving)
  - patient has poor concentration
- Difficulty with general anaesthetics (e.g. postoperative cardiopulmonary complications)
- Difficult to control blood pressure (or other cardiovascular disease)

2. RISK FACTORS FOR OBSTRUCTIVE SLEEP APNOEA

- Obesity (body mass index more then 30 kg/m^2)
- Large neck circumference (more than 42 cm for women or 44 cm for men)
- Retrognathia
- Maxillary restriction
- Nasal obstruction
- Crowded oropharynx (Mallampati index of C or D; see Figure 2)

on assessment of the upper airway (e.g. retrognathia, maxillary restriction). Untreated OSA is associated with a significant increase in postoperative complications leading to respiratory failure, which is the most costly group of postoperative complications.[6,7] About 10% of the Australian population have a general anaesthetic per annum. Elective surgical patients usually complete a preoperative questionnaire that asks about OSA symptoms. Emergency patients often have an increased rate of complications such as respiratory failure, suggesting possible preoperative undetected OSA. Consequently anaesthetists can have a significant role in identifying patients at risk of OSA.

ASSESSMENT

A suggested pathway for investigation of the snoring patient is shown in the flowchart on page 45. Assessment should begin with a thorough history and examination, in particular seeking symptoms and risk factors for OSA (Boxes 1 and 2). Potentially reversible contributory lifestyle factors should be identified, such as excessive alcohol ingestion, sedating medications, allergic rhinitis and weight gain. Examination should include measurement of body mass index, neck circumference, Mallampati score of the oropharynx (Figure 2) and systemic blood pressure.[8]

Further assessment depends on the severity of snoring and OSA. If the snoring appears benign (bed partner sleeps comfortably with the patient, no daytime sleepiness, no cardiovascular disease and no postoperative complications) then a conservative approach is reasonable without further investigation.

Conservative measures to reduce snoring and OSA include:

- reducing body weight if overweight or obese
- minimising alcohol use
- reducing nasal resistance with a nasal corticosteroid spray (a trial of at least four weeks)
- minimising medications that sedate or cause weight gain
- sleeping in a lateral position (i.e. recovery or first aid position) with one or two pillows and raising the head of the bed 5 to 10 cm.

Expiratory nasal valves have been developed in recent years; these are small

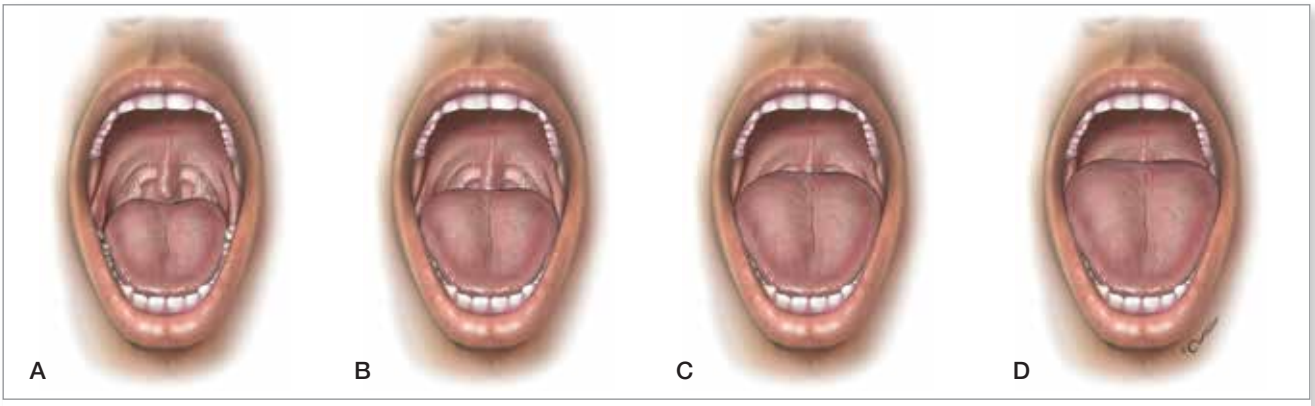


Figure 2. The Mallampati score (A to D) describes the visibility of the posterior pharyngeal wall when the patient is seated, head in neutral position, with mouth wide open, relaxed tongue, no phonation and no tongue depressor.[8] It is a predictor of obstructive sleep apnoea as well as the difficulty of intubation.

one-way values that adhere to the nares and allow normal inspiration but increase expiratory resistance, thereby providing expiratory positive airway pressure. However, randomised controlled trials to date have not had consistently favourable results.[9]

If a patient has troublesome snoring despite the above conservative measures or is deemed high risk (sleepiness, cardiovascular disease or potential anaesthetic difficulties) then further investigation and management is required.

INVESTIGATIONS FOR OSA

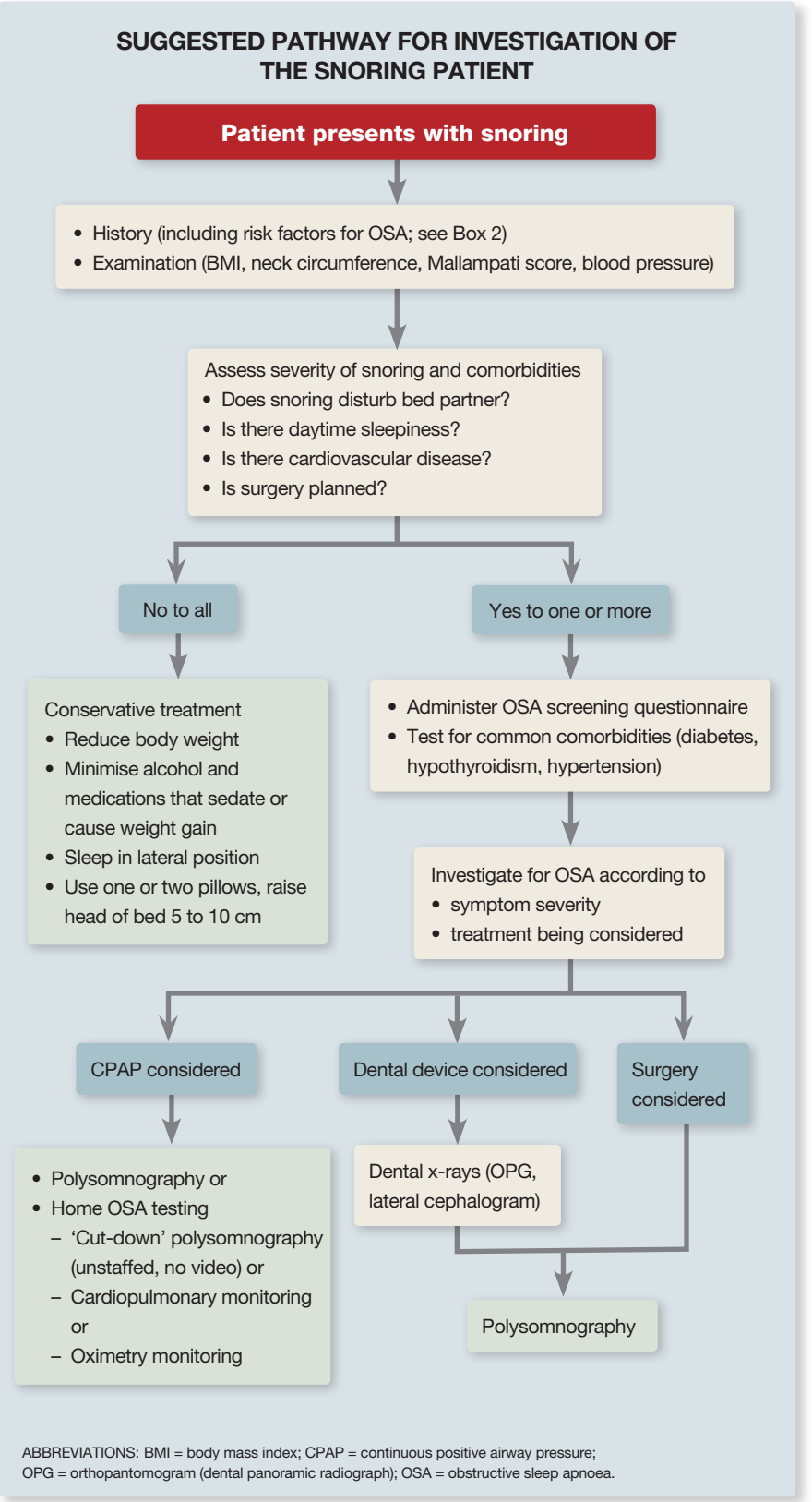
The investigation of patients with OSA depends on a number of factors, including patient clinical factors, the skill base of the healthcare provider, planned management and the location (urban, regional or remote) of the patient and healthcare provider.

Investigations for sleep apnoea should include assessment of common coexisting medical conditions. These include endocrine tests for diabetes and hypothyroidism and, if dental device therapy is being considered, radiology to assess dental hygiene (orthopantomogram, OPG) and craniofacial structure (lateral cephalogram).

Simple screening tests such as the Berlin and STOP-Bang questionnaires can be useful to determine the risk of OSA and identify snorers who require further investigation (available at www.britishsnoring.co.uk/berlin_questionnaire.php and www.stopbang.ca).[10,11]

Polysomnography

Various 'levels' of sleep apnoea testing exist. The most detailed testing is laboratory-based polysomnography, which involves monitoring the brain (electroencephalogram, electro-oculogram and electromyogram), heart (heart rate and rhythm, blood pressure), ventilation (nasal and oronasal airflow, chest and abdominal respiratory effort, oxygenation, exhaled carbon dioxide concentration, body position (video) and noise. Staff are continuously present in the event of technical or signal difficulties.



ABBREVIATIONS: BMI = body mass index; CPAP = continuous positive airway pressure; OPG = orthopantomogram (dental panoramic radiograph); OSA = obstructive sleep apnoea.

3. TREATMENTS FOR OBSTRUCTIVE SLEEP APNOEA

Conservative
- Minimise alcohol and body weight
- Treat rhinitis
- Minimise medications that sedate or cause weight gain
- Raise head of bed 5 to 10 cm
- Sleep in lateral position

Dental
- Palate expander
- Tongue retaining devices
- Mandibular advancement

Surgical
- Soft tissue
  - Adenotonsillectomy
  - Correction of nasal obstruction
  - Uvulopalatoplasty
  - Tongue base reduction
- Bony
  - Maxillary expansion advancement
  - Mandibular advancement
- Bariatric
  - Gastric banding
  - Gastric sleeve
  - Duodenal bypass

Continuous positive airway pressure
- Pressure
  - fixed
  - autoadjusting
  - bilevel
- Humidification
- Mask selection: nasal, intranasal, oronasal, facial or hood

Other
- Expiratory nasal valves
- Upper airway muscle pacemaker
- Positional therapy (use of small devices to help maintain a lateral position during sleep)

Home testing for sleep apnoea

Three home testing options exist for sleep apnoea. A 'cut-down' version of polysomnography can be performed without staff in attendance, accurate assessment of body position or measurement of exhaled carbon dioxide concentration. Patients can be 'wired up' at home or in a central laboratory. In these cases, inadequate signal acquisition is estimated to be as high as 15%.

A more limited form of cardiopulmonary monitoring (continuous heart rate and rhythm, oxygenation, airflow and respiratory effort, no electroencephalogram) is useful with less signal failure. Finally, simple oximetry can provide high fidelity monitoring of oxygen and heart rate changes and is considered relatively free of failure and useful in identifying high-risk patients at low cost.

The major limitation of all home-testing options is the lack of accurate monitoring of body position and absence of staff to maintain signal quality.

Selection of investigations and treatment

Selection of investigations depends on the severity of the patient's condition and the treatment options being considered. Treatment options for troublesome snoring are listed in Box 3. They include conservative, dental and surgical options and continuous positive airway pressure (CPAP).

Continuous positive airway pressure

After a thorough assessment, patients who are considered likely to be treated with CPAP can undergo simple home screening, and thereafter CPAP is gradually increased in response to further episodes of apnoea, hypopnoea or snoring. Unfortunately, adherence to CPAP is poor, estimated to range from 25 to 75%.[12] Although this level of adherence is similar to that for other medical therapies, CPAP therapy has the advantage that adherence can be accurately assessed by the device and results downloaded by the clinician and used to assist treatment. Adherence can be improved by thorough clinical assessment, accurate diagnosis and meticulous attention to the inconveniences that sometimes occur with CPAP. For example, rhinitis can be treated with a nasal corticosteroid spray or by adjusting the humidifier, CPAP pressure or mask.

Dental devices

Patient selection is extremely important for treatment with dental devices. In general, the patient's teeth should be healthy and sufficient in number and there should be clear nasal passages and no temporomandibular discomfort. Ideal patients for this therapy are not obese, have mild hypoxaemia and mild to moderate AHI with a large positional element (i.e. worse when sleeping on the back, less when on the side or prone). Therefore, the ideal test for these patients is a device that accurately measures body position in addition to episodes of apnoea and hypopnoea. The best assessment of positionality is by video recording.

Surgery

In patients in whom surgery is being considered (e.g. children with enlarged tonsils, adults with fixed nasal obstruction or obesity requiring bariatric surgery), polysomnography may be best because it can accurately assess positionality, differentiates nasal versus oral airflow, and detects cardiac arrhythmias. Randomised controlled trials have found favourable results after tonsillectomy in children with OSA and possibly after uvulopalatopasty in highly selected patients after the use of CPAP and a dental device had failed.[13,14]

THE FUTURE

The future of sleep apnoea research includes understanding the complexity of coexistent sleep disorders and cardiovascular disease, accurate upper airway assessment and novel therapies, which may include upper airway muscle pacemakers using hypoglossal nerve stimulation, positional therapy and possibly long-acting surfactant-containing sprays.

CONCLUSION

Snoring can be socially disturbing and associated with OSA and cardiovascular disease. It is widely believed among sleep

specialists that snoring can be on a par with smoking as a cardiovascular risk factor. When snoring is moderate to severe in intensity, it is usually associated with excessive daytime sleepiness and increased perioperative risk. Clinical assessment should include a thorough history and examination to identify potentially reversible contributory lifestyle factors. Standardised questionnaires can help clinicians identify patients who need further investigation. Investigations range from simple overnight oximetry at the patient's home to detailed polysomnography in a sleep laboratory. Choice of investigation depends on the severity of the patient's condition, treatment planned and clinician experience. MT

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COMPETING INTERESTS: Professor Naughton has received support for investigator-directed research and has in the past served on advisory boards for ResMed, Philips Respironics and Fisher & Paykel. He has also served on committees for the Australian Government Department of Health and Australasian Sleep Association to advise on sleep monitoring.
Dr Kee: None.