Sleep disordered breathing and its treatment in congestive heart failure

L J Cormican and A Williams

*Heart* 2005 91: 1265-1270
doi: 10.1136/hrt.2004.048314

Updated information and services can be found at:
http://heart.bmj.com/content/91/10/1265.full.html

These include:

**References**
This article cites 69 articles, 42 of which can be accessed free at:
http://heart.bmj.com/content/91/10/1265.full.html#ref-list-1

Article cited in:
http://heart.bmj.com/content/91/10/1265.full.html#related-urls

**Email alerting service**
Receive free email alerts when new articles cite this article. Sign up in the box at the top right corner of the online article.

**Notes**

To request permissions go to:
http://group.bmj.com/group/rights-licensing/permissions

To order reprints go to:
http://journals.bmj.com/cgi/reprintform

To subscribe to BMJ go to:
http://journals.bmj.com/cgi/ep
Sleep disordered breathing and its treatment in congestive heart failure

L J Cormican, A Williams

Sleep disordered breathing (SDB) is a common problem with adverse cardiorespiratory, endocrinological, and endothelial effects. Recent studies demonstrate an even higher prevalence of SDB in congestive heart failure (CHF) than in a randomly selected population, with up to 40% and 11% having Cheyne Stokes respiration–central sleep apnoea and obstructive sleep apnoea–hypopnoea syndromes, respectively. Randomised controlled trials of nocturnal respiratory support for SDB associated with CHF for up to three months demonstrate significant benefits in terms of improvements in left ventricular ejection fraction, markers of sympathetic system activity, and quality of life. Further randomised controlled trials of larger scale and longer duration are required to establish the role and benefit of this intervention for the treatment of this debilitating condition. The evidence for the higher prevalence of SDB in CHF, its pathogenesis, its pathophysiological consequences, and the emerging benefits of respiratory support are reviewed.

Congestive heart failure (CHF) remains a leading cause of morbidity and mortality worldwide. Randomised controlled trials have shown significant benefits of pharmacological treatment based on the attenuation of adrenergic drive through selective β blockade or manipulation of the renin–angiotensin–aldosterone system. More recently cardiac resynchronisation has developed as a new treatment modality for specific patients with CHF. However, the survival benefits manifested in such trials have yet to translate into a dramatic reduction in CHF mortality.

It is therefore important to identify and explore all of the factors that may alter the prognosis of heart failure, to facilitate the development of additional treatment options.

Sleep disordered breathing (SDB) in CHF is a burgeoning field of research, which offers insight into pathophysiological mechanisms and has treatment potential.

Undiagnosed SDB is a common problem affecting up to 24% and 9% of randomly selected middle aged men and women, respectively, with 4% and 2% having obstructive sleep apnoea–hypopnoea syndrome (OSAHS). Prevalence data on CSA in the healthy adult population are lacking.

There is, however, evidence of a higher prevalence of SDB in the heart failure population than in the normal population. Obstructive sleep apnoea is also associated with increased odds of developing heart failure independent of other risk factors.

**DIAGNOSIS AND CLASSIFICATION**

The primary parameter used to quantify SDB is the apnoea–hypopnoea index (the mean number of apnoeic and hypopnoeic events an hour during a night’s sleep). Five or more an hour are regarded as significant and are classified as either obstructive or central. Table 1 outlines the diagnostic criteria for the classification of SDB.

Obstructive apnoeas and hypopnoeas result from complete or partial collapse of a narrowed pharynx, respectively. Central sleep apnoeas and hypopnoeas can result from either a reduction in central respiratory drive (as occurs in brainstem pathology or respiratory muscle weakness, thus associated with hypventilation and hypercapnia) or an instability in feedback control of the central respiratory centre (as occurs in CHF, but it is often idiopathic and not associated with hypercapnia). Cheyne-Stokes respiration (CSR) is a form of periodic breathing with oscillations in tidal volume associated with central apnoea and hypopnoea, often referred to as CSR-CSA.

Table 2 outlines a basic classification of sleep studies. Attended nocturnal polysomnography is considered the ideal diagnostic modality for the diagnosis of the cause of SDB, although it is clearly not widely available.

However, guidelines advise that level II and III studies are acceptable for the diagnosis and assessment of treatment for SDB in the adult population. There is not yet guidance for the use of these studies on the diagnosis and assessment of SDB in the CHF population. Level IV studies, a combination of continuous pulse rate and oxyhaemoglobin saturation recording, though not recommended for the diagnosis and classification of SDB, have a role as a screening tool for SDB in an adult population. Level III studies, which can also be performed in the home, record more detailed information (pulse rate, respiration).
In a prospective study of 81 consecutive patients with predominantly New York Heart Association class I and II heart failure (caused by ischaemia, alcohol, and idiopathic cardiomyopathy) and a mean ejection fraction of < 30%, 51% of patients had significant evidence of SDB. Of those, 78% had CSA and 22% had OSAHS. In a population of 450 patients with CHF and symptoms of SDB referred for polysomnography, the prevalence of SDB, CSA, and OSAHS was 61%, 29%, and 32%, respectively. Similarly in a series of 35 consecutive patients with CHF, the prevalence of the same disorders was 65%, 37%, and 28%, respectively. There is some evidence that the prevalence of CSA is increased in CHF populations with increasing disease severity. In a study of consecutive patients presenting with acute left ventricular failure, the prevalence of SDB, CSR-CSA, and OSAHS was 82%, 75%, and 25%, respectively, within one month of presentation and treatment. CSR-CSA syndrome affected up to 45% in a series of consecutive patients awaiting cardiac transplantation. However, the strength of this relation has recently been questioned.

On the other hand, prospective studies of consecutive patients who have OSAHS provide evidence of left ventricular dysfunction when all other causes of left ventricular dysfunction have been excluded (coronary artery disease, CHF caused by cardiomyopathy or valvar heart disease, hypertension, and hypertrophic cardiomyopathy). Therefore, SDB can occur as a consequence of CHF but may also exacerbate the disease process.

However, it must be highlighted that larger epidemiological studies are required to quantify more accurately the prevalence of SDB and its subclassifications in the CHF population. Such studies will also add to our understanding of the impact of more recently introduced treatment modalities such as β-blockade and biventricular pacemaker insertion on the prevalence of SDB, especially CSR-CSA, in CHF.

### EPIDEMIOLOGY OF SLEEP DISORDERED BREATHING IN CONGESTIVE HEART FAILURE

In a prospective study of 81 consecutive patients with CHF, level III studies are more widely available than level I or II studies for the assessment of SDB at a secondary care level through sleep disorders clinics.

### PATHOGENESIS

The pathogenesis of CSR-CSA in CHF has recently been elucidated. Hyperventilation with reduction of arterial carbon dioxide pressure below a threshold is critical to the initiation of CSR-CSA independent of circulation time. However, there is a significant correlation between lung to chemoreceptor circulation time and the length of the CSR-CSA cycle. Hyperventilation in the setting of CHF is believed to occur due to the stimulation of lung vagal irritant receptors as a consequence of pulmonary congestion as indicated by higher pulmonary capillary wedge pressure in patients with CHF associated with CSR-CSA than in those without.

Hyperventilation may also occur due to increased ventilatory sensitivity to carbon dioxide, as patients with CHF associated with CSR-CSA have a greater ventilatory responsiveness to carbon dioxide than do those without. Risk factors for the occurrence of CSR-CSA in a CHF population are male sex, atrial fibrillation, age greater than 60, and daytime hypocapnia.

The reason for the increased prevalence of OSAHS in CHF is less clear. The coexistence of both may also be a function of their respective high prevalence in the adult population. On the other hand, sleep onset is associated with loss of pharyngeal dilator muscle tone, which in the setting of normal pharyngeal anatomy is not associated with airway compromise. In patients with OSAHS, the pharynx is

---

### Table 1: Diagnostic criteria for the classification of SDB (based on the American Academy of Sleep Medicine Task Force) on the basis of the combination of symptoms or signs and findings on overnight monitoring

<table>
<thead>
<tr>
<th>Syndrome</th>
<th>Symptoms and signs</th>
<th>Overnight monitoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>OSAHS</td>
<td>Excessive daytime sleepiness not explained by other factors or two or more of the following: choking or gasping during sleep; recurrent awakenings from sleep; unrefreshing sleep; daytime fatigue; impaired concentration</td>
<td>Five or more obstructed breathing events/hour, any combination of apnoea, hypopnoea, and respiratory effort related arousal</td>
</tr>
<tr>
<td>CSA-HS</td>
<td>One or both of excessive daytime sleepiness and frequent nocturnal arousals or awakenings</td>
<td>Five or more central apnoic and hypopnoeic events/hour and normal daytime PCO2 (&lt; 6 kPa)</td>
</tr>
<tr>
<td>CSR-CSA</td>
<td>CHF or cerebral neurological disease</td>
<td>Three or more consecutive cycles of cyclical crescendo and decrecendo change in breathing amplitude and five or more central apnoeic and hypopnoeic events/hour or a cycle of crescendo-decrecendo change in breathing amplitude lasting 10 minutes or more</td>
</tr>
</tbody>
</table>

CHF, congestive heart failure; CSA, central sleep apnoea; CSR, Cheyne Stokes respiration; HS, hypopnoea syndrome; OSAHS, obstructive sleep apnoea-hypopnoea syndrome; PCO2, partial pressure of carbon dioxide; SDB, sleep disordered breathing.

---

### Table 2: Types of sleep studies (based on the American Academy of Sleep Medicine Task Force)

<table>
<thead>
<tr>
<th>Level</th>
<th>Components</th>
<th>Location performed</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Electroencephalogram, electro-oculogram, submental EMG, nasal/oral airflow, respiratory movement, oximetry, ECG, anterior tibialis EMG, sleeping position</td>
<td>Sleep laboratory</td>
<td>Complete attended study; facilitates determination of wake and sleep states, sleep stages, and disturbance, AHI, and detection of sleep pathology unrelated to SDB</td>
</tr>
<tr>
<td>II</td>
<td>Same as level I</td>
<td>Home</td>
<td>Same as level I but an unattended study</td>
</tr>
<tr>
<td>III</td>
<td>Partial study measuring nasal/oral airflow, respiratory movement, oximetry, pulse rate, sleep position</td>
<td>Home</td>
<td>Unattended study; allows detection of respiratory and cardiac events but no information about wake and sleep stages and stages of sleep disturbance and non-SDB sleep pathology</td>
</tr>
<tr>
<td>IV</td>
<td>Pulse rate, oximetry</td>
<td>Home</td>
<td>Unattended study; least expensive, useful screening tool for OSAHS</td>
</tr>
</tbody>
</table>

AHI, apnoea–hypopnoea index; EMG, electromyogram.
already mentioned occurs in CHF patients as a result of carbon dioxide as reflected by P\textsubscript{CO}2. Hyperventilation as tance.\textsuperscript{36,37} vasoconstriction, and raised peripheral vascular resistance further augment sympatheic discharge during normal breathing, ceases during apnoea, facilitating sympathetic outflow.\textsuperscript{15} The associated hypoxia and hypercapnia further augment sympathetic activity by simulating peripheral and central chemoreceptors. The consequences are increased heart rate, vasoconstriction, and raised peripheral vascular resistance.\textsuperscript{16,17} The pathophysiological impact of OSAHS extends into wakefulness, with it now being recognised as an independent risk factor for hypertension\textsuperscript{18,19} and it being associated with left ventricular hypertrophy in normotensive patients.\textsuperscript{20} Obstructive sleep apnoea syndrome is now recognised as an independent risk factor for increased insulin resistance. Furthermore, treatment with continuous positive airway pressure (CPAP) has been shown to increase insulin sensitivity in these patients.\textsuperscript{21} There is also evidence that OSAHS may have potential detrimental endothelial effects. Patients with OSAHS have higher plasma C reactive protein concentrations\textsuperscript{22} than controls, they have signs of increased oxidative stress, such as increased reactive oxygen species production in neutrophils,\textsuperscript{23} and they have increased serum concentrations of intracellular adhesion molecule 1 and vascular cell adhesion molecule 1.\textsuperscript{24}\textsuperscript{25} There are some reports that OSAHS alone can also act as an independent risk factor for the development of left ventricular dysfunction. In patients without a history of CHF or coronary artery disease, the presence of OSAHS is associated with evidence of left ventricular systolic\textsuperscript{26} and diastolic dysfunction.\textsuperscript{27,28} Nocturnal CPAP for six months results in the correction of these indices. Furthermore, normotensive patients with OSAHS have increased left ventricular wall thickness in comparison with controls.\textsuperscript{29} The presence of CSR-CSA additionally has an adverse prognostic impact and pathophysiological burden on patients with CHF. It is associated with a higher mortality even after adjustment for other disease severity risk factors.\textsuperscript{30,31} The adverse effects of CSR-CSA probably arise from similar factors described for OSAHS including intermittent hypoxia, frequent arousals from sleep, sympathetic system activation, and apnoea related surges in blood pressure and heart rate, but without the effects of negative intrathoracic pressure during apnoeic events.

EVIDENCE FOR THE TREATMENT OF SDB IN CHF

There is compelling evidence for the treatment of OSAHS with CPAP irrespective of whether patients have CHF.\textsuperscript{32,33} The physiological benefits are reduced frequency and severity of desaturations, heart rate variability, apnoea, hypopnoeic events,\textsuperscript{34} daytime somnolence,\textsuperscript{35,36} and improved control of hypertension\textsuperscript{37} and neuropsychological symptoms.\textsuperscript{38} There is also evidence that the treatment of OSAHS in CHF with CPAP has additional positive physiological and clinical benefits by abolishing apnoea related hypoxia, lowering nocturnal blood pressure, improving sleep quality\textsuperscript{39} and ejection fraction,\textsuperscript{32,33} and reducing catecholamine production\textsuperscript{32} (table 3). Two randomised controlled trials of CPAP for OSAHS associated with CHF have confirmed that these improvements in ejection fraction are significant (5%\textsuperscript{36} and 8.8%\textsuperscript{35}) and that they are associated with improvements in symptoms.\textsuperscript{36,37} Even in the absence of evidence of CHF or a primary cardiac disease, there is some evidence (albeit from uncon- trolled trials with small numbers) that the treatment of OSAHS for six months or longer results in a significant increase in left ventricular ejection fraction.\textsuperscript{38–40} These changes are believed to be caused by the relative increase in intrathoracic pressure due to CPAP, resulting in a reduction in cardiac transmural pressure. The reduction in transmural pressure in conjunction with the reduction of nocturnal blood pressure leads to a reduction in left ventricular afterload.\textsuperscript{41} However, larger and longer term randomised controlled studies recruiting treatment naive patients with OSAHS without cardiovascular morbidity at baseline are required to determine whether OSAHS can cause CHF directly. There is also evidence from randomised controlled trials that CPAP has a significant beneficial effect on CSR-CSA caused by CHF when applied for at least 1–3 months\textsuperscript{42–45} (table 4). The benefits were a reduced apnoea–hypopnoea index and improved ejection fraction (6.5% to 8.6%), New York Heart Association (NYHA) functional status, and symptom score. This is postulated to be caused by reduced minute ventilation, with an increase in arterial carbon dioxide pressure (possibly above the apnoea threshold) during sleep as a consequence of reduced lung vagal irritant

www.heartjnl.com
receptor stimulation due to reduced pulmonary congestion. Concern has been raised over the possible adverse haemodynamic effects of the use of CPAP in severe CHF (NYHA class III to IV) associated with atrial fibrillation in one study.

Overall, the sample sizes of these studies are small, the periods of follow up are short, and possibly as a consequence only one study has reported a reduction in mortality. Larger longer term follow up studies are required to address the mortality benefits and to clarify the subgroups of patients with CHF who are susceptible to the potential adverse haemodynamic effects of the use CPAP.

Additional forms of respiratory support have been examined in this context.

Pressure support adaptive servo- (non-invasive) ventilation, a hybrid form of respiratory support that can cycle between pressure support during hypopnoea and ventilatory support during apnoea, is as effective as CPAP for the treatment of CSR-CSA in patients with CHF in terms of indices of SDB, neurohumoral activation, and reduced daytime somnolence over a period of a month. Bilevel non-invasive ventilation has also been proved to be an effective alternative to CPAP in the treatment of CSR-CSA caused by CHF.

The first randomised controlled trials of respiratory support for the treatment of OSAHS associated with CHF have recently been published (table 3). In both, patients were treated with CPAP for periods of 1–3 months. In comparison with the control groups, the CPAP treated groups exhibited an increase in left ventricular ejection fraction of 5% and 8.8%, Furthermore, mean daytime systolic blood pressure (126 to 116 mm Hg), heart rate (68 to 64 beats/min), and left ventricular end systolic dimension (54.5 to 51.7 mm) changed significantly. Sympathetic nervous system activity as measured by overnight urinary noradrenaline (norepinephrine) excretion was reduced in the treatment group and indices of quality of life were improved (fatigue, disease mastery, and emotional wellbeing as measured by the chronic heart failure questionnaire).

This treatment for this specific CHF patient population compares favourably with the effects of β blockade and angiotensin converting enzyme inhibition in CHF as shown by randomised controlled trials. However, as mentioned above, this evidence is limited by a lack of a demonstrable impact on mortality, possibly as a result of sample size and the duration of follow up.

Larger prospective trials such as the ongoing CANPAP (Canadian continuous positive airway pressure) trial are required to delineate the precise benefit and roles of CPAP in the treatment of SDB in CHF.

Table 3 Randomised controlled trials of nocturnal respiratory support in patients with OSAHS associated with CHF

<table>
<thead>
<tr>
<th>Trial</th>
<th>Patient characteristics</th>
<th>Intervention</th>
<th>Duration of treatment</th>
<th>No of patients</th>
<th>Cardiovascular outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kaneko et al</td>
<td>ICM, DCM</td>
<td>CPAP</td>
<td>1 month</td>
<td>24</td>
<td>8.8% increase in LVEF, reduced LVESD, reduced heart rate and SBP</td>
</tr>
<tr>
<td>Mansfield et al</td>
<td>Not stated</td>
<td>CPAP</td>
<td>3 months</td>
<td>55</td>
<td>5% increase in LVEF, reduced fatigue and overnight urinary noradrenaline excretion, increased disease mastery and emotional wellbeing (CHFQ)</td>
</tr>
</tbody>
</table>

CHFQ, Guyatt chronic heart failure questionnaire; CPAP, continuous positive airway pressure; DCM, dilated cardiomyopathy; ICM, ischaemic cardiomyopathy; LVESD, left ventricular end systolic dimension; NYHA, New York Heart Association; SBP, systolic blood pressure.

Table 4 Randomised controlled (and crossover) trials of nocturnal respiratory support in patients with CSR-CSA associated with CHF

<table>
<thead>
<tr>
<th>Trial</th>
<th>Patient characteristics</th>
<th>Intervention</th>
<th>Duration of treatment</th>
<th>No of patients</th>
<th>Cardiovascular outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Naughton et al</td>
<td>ICM, DCM</td>
<td>CPAP</td>
<td>1 month</td>
<td>18</td>
<td>6.5% increase in LVEF, reduced nocturnal urine and daytime serum noradrenaline</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>7.7% increase in LVEF, reduced fatigue and dyspnoea, increased emotional well being and disease mastery (CHFQ)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>8.6% increase in LVEF, reduced dyspnoea and fatigue (CHFQ)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>8% increase in LVEF, 81% relative risk reduction in mortality and transplantation rate</td>
</tr>
<tr>
<td>Granton et al</td>
<td>ICM, DCM</td>
<td>CPAP</td>
<td>3 months</td>
<td>29</td>
<td>APSSV reduced AHI and arousal index more than did CPAP, bilevel ventilation or oxygen supplementation; change in LVEF not measured</td>
</tr>
<tr>
<td>Sin et al</td>
<td>ICM, DCM</td>
<td>CPAP</td>
<td>3 months</td>
<td>66</td>
<td>Reduced serum BNP, urinary metadrenaline, and daytime somnolence; change in LVEF not measured</td>
</tr>
<tr>
<td>Teschner et al</td>
<td>Fractional shortening</td>
<td>APSSV, Bi-V, CPAP, supplemental oxygen</td>
<td>4 nights (crossover trial)</td>
<td>14</td>
<td>Bilevel ventilation and CPAP equally improved circulation time; improved sleep quality, reduced daytime fatigue (SF-36) and NYHA class; change in LVEF not measured</td>
</tr>
<tr>
<td>Peppereil et al</td>
<td>ICM, DCM</td>
<td>APSSV</td>
<td>1 month</td>
<td>30</td>
<td>APSSV reduced AHI and arousal index more than did CPAP, bilevel ventilation or oxygen supplementation; change in LVEF not measured</td>
</tr>
<tr>
<td>Kahnlein et al</td>
<td>ICM, DCM</td>
<td>Bi-V/CPAP</td>
<td>1 month</td>
<td>18</td>
<td>Bilevel ventilation and CPAP equally improved circulation time; improved sleep quality, reduced daytime fatigue (SF-36) and NYHA class; change in LVEF not measured</td>
</tr>
</tbody>
</table>

APSSV, adaptive pressure support servoventilation; Bi-V, bilevel non-invasive ventilation; BNP, brain natriuretic peptide; NA, not available; SF-36, short form 36 questionnaire.
not been shown to cause improvements in ventricular function, quality of life, or clinical outcomes. Atrial
overdrive pacing has recently been shown by one group to reduce the number of episodes of central and obstructive
apnoea in a cohort of patients with SDB without CHF. The mechanism by which this occurs is a matter of debate. It may
be related to the effect of an augmentation in cardiac output reducing pulmonary congestion, a stimulus for hyperventila-
tion, and to a reduction in circulation time. Further studies are awaited to determine whether this effect can be repro-
duced.

Lifestyle modification resulting in weight loss reduces the severity of OSAHS, possibly through a decrement in upper
airway collapsibility in an obese non-CHF population. Though there is no such evidence for an obese CHF
population, presumably the same should occur.

CONCLUSION
The presence of SDB presents another treatment opportunity in CHF. There is now a burgeoning field of evidence that
respiratory support for these patients has considerable potential in treating obstructive sleep apnoea.

The effect of ventilation in the treatment of CHF.

REFERENCES
Authors' affiliations

18 Naughton M, Bernard D, Tam A, et al. Role of hyperventilation in the
pathogenesis of central sleep apnoea in patients with congestive heart failure.
19 Chemnick N. Apnoea and periodic breathing during sleep. N Engl J Med
20 Flemons W, Douglass N, Kuna S, et al. Access to diagnosis and treatment of
patients with suspected sleep apnea. Am J Respir Crit Care Med
apnoea in patients referred for acute left ventricular failure and medically
ventricular dysfunction: prevalence and implications for arrhythmogenic risk.
24 LaBaron J, Pascal-Sebagon S, Block E, et al. Left ventricular systolic dysfunction
dysfunction in patients with obstructive sleep apnoea syndrome. Eur Respir J
2002;20:1239–45.
26 Solin P, Bergin P, Richardson M. Influence of pulmonary capillary wedge
27 Javaheri S. A mechanism of central sleep apnoea in patients with heart
the pharynx in obese subjects with obstructive sleep apnoea and weight
30 Alex C, Onal E, Lapato M. Upper airway occlusion during sleep in patients
pressure on upper airway size in patients with obstructive sleep apnoea.
obstructive to central apnoea in patients with heart failure: role of PCO2 and
obstructive apnoea in humans with and without heart failure. Chest
septum and pulsum paradoxus in obstructive sleep apnoea. Chest
35 Somers V, Dyken M, Clary M, et al. Sympathetic neural mechanisms in
36 Morgan B, Denohar T, Ebert T, et al. Neurocirculatory consequences of
negative intrathoracic pressure vs. asphyxia during voluntary apnoea.
37 Somers V, Mark A, Zavala D, et al. Contrasting effects of hypoxia and
hypocapnia on ventilation and sympathetic activity in humans. J Appl Physiol
38 Williams A, Houston D, Finberg S, et al. Sleep apnoea syndrome and
40 Hedner J, Epron H, Caidahl K. Left ventricular hypertrophic independence of
treatment in patients with obstructive sleep apnoea. J Hypertens
1990;8:941–6.
pressure treatment really improves insulin sensitivity in patients with
obstructive sleep apnoea syndrome. Am J Respir Crit Care Med
42 Shamsuzzaman A, Winnicki M, Lanfranchi P, et al. Elevated C-reactive
protein in patients with obstructive sleep apnoea. Circulation
43 Schulz R, Mahmoudi S, Hattar K, et al. Enhanced release of superoxide from
polymorphonuclear neutrophils in obstructive sleep apnoea; impact of
continuous positive airway pressure therapy. Am J Respir Crit Care Med
2000;162:566–70.
coronary artery disease and moderate to severe obstructive sleep apnoea.
45 Hansly P, Zuberi-Kholik H. Increased mortality associated with Cheyne-Stokes
46 Lanfranchi P, Braghieri A, Basimini E, et al. Prognostic value of nocturnal
Cheyne-Stokes respiration in chronic heart failure. Circulation
48 Berman H, Martin S, Kingshott R, et al. Randomised placebo controlled trial
of daytime function after continuous positive airway pressure (CPAP)
49 Marrone O, Ferrara G, Macaluso C. Sleep related disorders and internal
51 Faccenda J, Mackay T, Boon N, et al. Randomized placebo-controlled trial of
continuous positive airway pressure on blood pressure in the sleep apnoea-

www.heartnl.com
A 55 year old man was admitted to hospital after collapsing while playing golf. During assessment in the emergency department the patient became unconscious and lost cardiac output associated with a sinus bradycardia of 40 beats/min, some non-specific changes in the inferior ECG leads, and normal myocardial injury markers. Coronary angiography demonstrated normal coronary arteries; however, a branch of the right coronary artery (RCA) supplying the right atrium (RA) was associated with a tissue blush (panel A). Transhoracic echocardiography (TTE) confirmed a mass in the RA and a global pericardial effusion (panel B). Transoesophageal echocardiography (TOE) showed a localised 3.5 x 3.5 cm tumour of the RA anterior wall (panel C). A computed tomographic (CT) scan of the chest showed no evidence of metastasis. Operative findings showed extension of the tumour to the surface of the RA and involvement of the RCA. The tumour was resected and a saphneous vein graft was anastomosed to the distal RCA. Histology confirmed angiosarcoma with a high mitotic rate and incomplete resection at the margin. A repeat operation with wider excision was performed with a clear histological margin. Five cycles of doxorubicin and ifosfamide chemotherapy were administered. Adjuvant radiotherapy to the site of the primary tumour was given. The patient died 11 months after primary diagnosis from CT proven metastatic disease.

This case demonstrates the unusual angiographic findings of a cardiac malignancy and its correlation with TTE and TOE echocardiographic images.