Management of Sleep Apnea in Heart Failure

Ali Vazir, MBBS, PhD, FESC, FRCP[a,b,*], Varun Sundaram, MD, FRCP[a,b,c]

KEYWORDS

• Sleep apnea • Heart failure • Adaptive servo-ventilation • CPAP

KEY POINTS

- Sleep apnea is common in patients with heart failure (HF), and is characterized by 2 phenotypes, central (CSA) and obstructive sleep apnea (OSA), and is associated with poor outcome.
- Patients with HF and sleep apnea do not usually report excessive daytime hypersomnolence, suggesting the need for screening.
- Registry data and small randomized controlled trials suggest that treatment of OSA in patients with HF with continuous positive airway pressure is beneficial; however, data from large randomized controlled studies are lacking.
- CSA is associated with severity of HF and improving the underlying HF may alleviate CSA.
- A recent randomized controlled trial of adaptive servo-ventilation (ASV) in patients with HF and CSA, despite ASV effectively alleviating CSA, ASV was associated with increased cardiovascular mortality.

INTRODUCTION

The prevalence of sleep-disordered breathing (SDB) in the general population is 2% to 4%,[1] in contrast SDB is much more common in patients with heart failure (HF), with the prevalence ranging between 50% and 75%.[2,3] The presence of SDB in patients with HF appears to be associated with increased risk of cardiovascular morbidity and mortality.[4] In this review, we describe the types, pathophysiology, and consequences of SDB and discuss ways in which SDB can be diagnosed. We also lay emphasis on the recent randomized controlled trials that have had a major impact on how SDB is managed and highlight the complex relationship between SDB and outcomes.

TYPES OF SLEEP-DISORDERED BREATHING AND PATHOPHYSIOLOGY

The predominant type of SDB in patients with HF is central sleep apnea (CSA), and is reported to occur in 45% to 55% of patients with HF,[2,3] with similar prevalence rates between the 2 main phenotypes of HF, reduced or preserved ejection fraction (ie, HFrEF or HFpEF).[5,6] The prevalence of SDB in decompensated HF may be higher.[7]

The presence of CSA is characterized by abnormal regulation of breathing within the respiratory centers located in the brainstem. The hallmark of CSA is the reduced or complete lack of efferent activity to respiratory pump muscles leading to periods of 10 or more seconds in which

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[a] Department of Cardiology, Royal Brompton Hospital, Royal Brompton and Harefield NHS Foundation Trust, Sydney Street, London SW3 6NP, UK; [b] Royal Brompton Hospital, National Heart and Lung Institute, Imperial College London, Dovehouse Street, London SW3 6LR, UK; [c] Case Western Reserve University School of Medicine, 2109 Adelbert Rd, Cleveland, Ohio 44106, USA

* Corresponding author. Royal Brompton and Harefield NHS Foundation Trust, Sydney Street, London SW3 6NP, UK.

E-mail address: A.vazir@imperial.ac.uk

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there is significantly reduced (hypopnea) or complete cessation (apnea) of respiratory effort (Fig. 1). Thus, during a central apnea there is reduced or absent chest wall and abdominal movement and airflow, which is associated with a dip in oxygen saturation and a rise in arterial carbon dioxide ($Paco_2$) and terminated by an arousal, which is characterized with a rise in heart rate and blood pressure. Cheyne-Stokes respiration (CSR) is another type of SDB, which is similar to CSA, but is characterized by crescendo-decrescendo oscillation of tidal volume, with intervals of hyperventilation separated by periods of hypopnea and apnea. A major feature of CSR is that the cycle length of the crescendo-decrescendo breathing pattern is characteristically prolonged compared with CSA and appears to correlate with circulation time. CSR also may be detected in patients who are awake at rest or during exercise in patients with severe and advanced HF.[8,9]

The pathophysiology of CSA and CSR is complex and not completely understood. The changes in $Paco_2$ levels appear to play an important role in the pathophysiology of CSA.

The central chemoreceptors can detect changes in levels of $Paco_2$, such that a rise in $Paco_2$ leads to increased respiratory effort. By contrast, a fall in $Paco_2$ will lead to reduced respiratory effort. Central apnea will result when $Paco_2$ falls below the apneic threshold: the point at which respiratory effort is no longer triggered. Patients with HF characteristically have $Paco_2$ close to the lower limit of normal or may have hypocapnia in response to stimulation of the pulmonary stretch receptors (J-receptors), which are sensitive to pulmonary congestion.[10] Furthermore, patients with HF have increased hypercapnic ventilatory response, also termed enhanced chemosensitivity to $Paco_2$.[11]

Thus, in patients with HF, the fluctuations in the level of $Paco_2$ below and above the apneic threshold may switch the breathing on and off, and result in periods of central apnea/hypopnea and hyperventilation. The presence of circulatory delay, leading to a time lag between changes in arterial CO_2 and O_2 in the lung and their detection in the central chemoreceptors in the brainstem, may lengthen the apnea/hypopnea cycle.[12]

Obstructive sleep apnea (OSA) is also more frequently observed in patients with HF compared with the general population, with reported prevalence of 10% to 15%.[2,3] OSA remains the commonest form of SDB in the general population. The pathophysiology of OSA is characterized by the collapse of the pharyngeal airway. The latter may be either complete or partial, leading to an obstructive apnea or hypopnea, respectively. Obstructive apnea may occur because of loss of pharyngeal dilator muscle tone during sleep. The tendency of pharyngeal collapse is increased with obesity, large neck size, and retrognathia, and in patients with HF the presence of pharyngeal edema due to rostral fluid shift during sleep.[13] An obstructive apnea is characterized by the absence of airflow, with continued but paradoxic chest wall

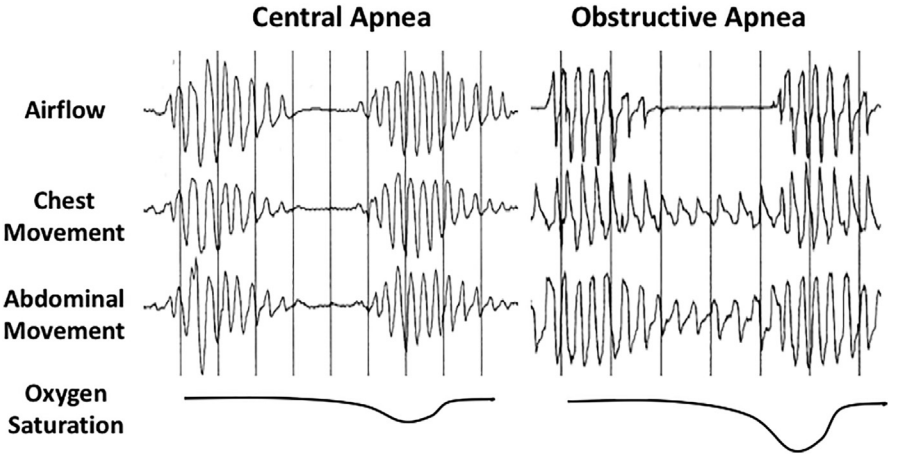

Fig. 1. Example of central and obstructive apnea with evidence of oxygen desaturation. Central apnea is characterized by absence of airflow of more than 10 seconds and lack of chest and abdominal movement, with associated oxygen desaturation, followed by period of hyperpnea (faster and deeper chest and abdominal movement) leading to increased airflow and rise in oxygen saturation level. Obstructive apnea is characterized by absence of airflow, but continued and paradoxic chest and abdominal movement, associated with a more marked oxygen desaturation compared with a central apnea, followed by hyperpnea with faster and deeper chest and abdominal movement and a rise in oxygen saturation.