Sleep and Heart Failure

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KEYWORDS

• Obstructive sleep apnea • Central sleep apnea • Sleep-disordered breathing
• Heart failure • Noninvasive ventilator support

KEY POINTS

- Sleep-disordered breathing (SDB) is frequently undiagnosed and untreated in heart failure.
- Due to its high prevalence and poor outcomes, active recognition and treatment are warranted.
- Early recognition and prompt treatment of SDB has the potential to reduce health care expenses and mitigate the development and progression of cardiovascular disease.

INTRODUCTION

Sleep was once thought to be a passive part of daily life: a time in which the body and brain were inactive. It is now known the brain remains very active during sleep, and the importance of sleep on optimal health and physical and mental performance is more appreciated. In fact, sleep should be restorative, allowing the body and brain to recover from activities of the previous day and to prepare for the next. Yet, sleep deprivation is endemic in the United States and has recently been called a "public health epidemic" by the Centers for Disease Control and Prevention.[1] The exact amount of sleep needed varies by individual and age, but the National Institutes of Health recommends at least 10 hours of sleep daily for school-age children, 9 to 10 hours for teenagers, and 7 to 8 hours for adults.[2] However, the National Health Interview Survey reported in 2014 that nearly 30% of adults averaged less than 6 hours of sleep.[3] Additionally the National Sleep Foundation reported, despite rating sleep as "extremely important" for their own and their children's health, parents failed to set good examples for sleep, enforce bedtime rules, or limit electronics in the bedroom.[2]

Sleep deprivation can be either acute or chronic in nature, as in jet lag or routinely working night shift, caused by developmental stages, as in having young children, related to societal factors, like hectic schedules or constant electronic connectivity,

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or result from poor sleep quality. Regardless, all produce reduced alertness, impaired concentration, and delayed reaction times. However, those with chronic sleep deprivation are more likely to develop hypertension, diabetes, depression, heart failure, or arrhythmias and experience increased mortality or decrements in quality of life and productivity.[4,5]

A frequent cause of poor sleep quality is sleep-disordered breathing (SDB), a disorder characterized by abnormalities in either the quality or quantity of respirations during sleep. In a population-based sample of adults aged 30 to 70, estimates are approximately 13% of men and 6% of women have moderate to severe SDB.[6] This represents a double-digit percentage increase from the previous decade, with obesity identified as a strong causal factor. In those with cardiovascular disease (CVD), the estimates of SDB are much higher, affecting 30% to 80% of hypertensive patients, 30% to 60% of patients with ischemic heart disease, and 50% to 80% of those with heart failure (HF).[5] Despite the high prevalence associated with SDB, attention, recognition, and treatment of this disorder are inadequate.

SLEEP PHYSIOLOGY

Sleep is a state of unconsciousness during which the brain is more responsive to internal, rather than external, stimuli.[7] Sleep is divided into non–rapid eye movement (NREM) and rapid eye movement (REM) stages. NREM makes up 80% to 85% of total sleep time and begins with stage 1 (the transition between wakefulness and sleep; also known as drowsiness), advances to stage 2 (decreased movement and fading of conscious awareness of the surroundings), and progresses to deeper sleep in stage 3.[8] During stage 3, the sleeper is totally unaware of the environment. Driven primarily by decreased metabolic needs, the respiratory rate declines, producing a rise in $Paco_2$, and parasympathetic nervous tone increases, such that heart rate and blood pressure are at their lowest. Brief arousals from sleep, lasting 3 to 15 seconds, result in a change to a lighter stage of NREM sleep but are not remembered by the sleeper. Because most time is spent in NREM, sleep should be a period of hemodynamic and cardiovascular tranquility.

The deepest level of relaxation follows NREM in REM sleep. REM is essential to awakening feeling rested and refreshed and is characterized by muscle atonia, cortical activation, and rapid eye movements.[7] The body is essentially paralyzed and unresponsive, but the brain is highly active and vivid dreams occur here. Respirations become irregular, rapid, and shallow, and atonia of the nondiaphragmatic respiratory muscles leads to hypoventilation and a fall in Pao_2 and concomitant rise in $Paco_2$. Heart rate and blood pressure increase. As expected, most arousals occur during NREM when muscle tone is lost and the body is essentially paralyzed.

Normal sleep progresses through NREM stages 1 to 3 in cycles lasting 90 to 110 minutes (4–6 cycles per night), before REM sleep occurs (**Fig. 1**). REM is then followed by more NREM stage 2 sleep, before resuming the progression toward deeper sleep. REM dominates the latter half of sleep with each REM cycle becoming progressively longer as awakening nears.

SLEEP-DISORDERED BREATHING

SDB can be categorized into obstructive sleep apnea (OSA), or patients who “cannot breathe” due to obstruction of the oropharyngeal airway, or central sleep apnea (CSA), or patients who “will not breathe,” due to the loss of respiratory drive. Of the two, OSA is the most common form of SDB and affects at least 25 million Americans.[8] In OSA, the thoraco-abdominal muscles continue the effort of breathing, but the movement of