Sleep Board Review Questions: Sleep Disordered Breathing that Improves in REM

Rohit Budhiraja, MD
Pulmonary, Allergy, Critical Care and Sleep Medicine
University of Arizona

Which of the following breathing disorders is usually less severe in rapid eye movement (REM) sleep compared to non-rapid eye movement (NREM) sleep?

1. Sleep-related hypoxemia in COPD
2. Obstructive Sleep Apnea
3. Cheyne Stokes Breathing
4. Hypoxemia in Pulmonary Hypertension

Correct!
3. Cheyne Stokes Breathing

Explanation: Several changes associated with sleep result in decrease in arterial oxygen (PaO2) during sleep. These include loss of behavioral control of ventilation (such as during speaking and swallowing), decreased responsiveness to hypercapnia and hypoxemia, reduced functional capacity of the lungs and decreased tidal volume and minute ventilation (1). Furthermore, there is a decrease in tone of skeletal muscles including the accessory muscles of respiration and upper airway muscles. Latter is associated with an increase in upper airway resistance. These effects are generally more pronounced during REM sleep compared to NREM sleep, leading to worse oxygenation during this sleep stage. Hence hypoxemia associated with COPD, pulmonary hypertension or OSA may frequently be worse during REM.
Cheyne-Stokes respiration with central sleep apnea (CSR-CSA) is characterized by a waxing-waning pattern of breathing with episodes of hyperventilation alternating with hypopneas or apneas. While the exact etiology of CSA–CSR is yet to be clearly elucidated, several factors might contribute to this pattern of breathing typically described in persons with heart failure (2). Comparing patients with heart failure with CSA-CSR and those without CSA-CSR reveals that former is associated with higher pulmonary capillary wedge pressure and increased central and peripheral chemosensitivity. Both these factors contribute to stimulation of ventilation, and thence, lower daytime and sleeping partial pressure of carbon dioxide in blood (Pa_{CO2}).
There is a failure of Pa_{CO2} to increase above apneic threshold during sleep in these patients, which leads to central apneas and rise in Pa_{CO2}. However, the enhanced sensitivity of chemeoreceptors to Pa_{CO2} then induces hyperventilation, ventilatory overshoot and hypocapnia, which again is followed by hypoventilation and central apneas. During REM, not only can the hypoventilation relative to NREM sleep lead to increase in the Pa_{CO2} to above the apneic threshold, but the loss in respiratory muscle tone and chemosensitivity leads to dampening of breathing changes associated with changes in PaCO2. This leads to a decrease in the propensity for the cyclical CSR-CSA. This cyclical pattern, hence, is more common in N1 stage than in deeper stages of NREM sleep and REM.

References

1. Smith DR, Lee-Chiong T. Respiratory physiology during Sleep. Sleep Med Clin 2008;3:497-503
2. Yumino D, Bradley TD. Central sleep apnea and cheyne-stokes respiration. *Proc* Am Thorac Soc 2008;5:226–36.