ELSEVIER

Sleep Medicine 1 (2000) 63–64

SLEEP MEDICINE

www.elsevier.com/locate/sleep

Journal search and commentary

Article reviewed: A mechanism of central sleep apnea in patients with heart failure ☆

Mark H. Sanders[a,b]

[a]*Pulmonary Sleep Disorders Program, Division of Pulmonary, Allergy and Critical Care Medicine, University of Pittsburgh School of Medicine, Pittsburgh, PA, USA*

[b]*Pulmonary Service, Pittsburgh Veterans Affairs Healthcare System, Pittsburgh, PA, USA*

Category

Sleep disordered breathing

Objective

To determine if central sleep apnea in patients with congestive heart failure (CHF) is related to augmented hypercapnic ventilatory responsiveness.

Study design

Prospective, controlled study design.

Study population

Twenty patients with CHF who were participating in a study to determine the prevalence of sleep apnea in CHF. This study was performed in an academically affiliated Veterans Affairs Medical.

Methods

Participants underwent nocturnal polysomnography (PSG) to characterize breathing during sleep. Sleep architecture was recorded using the standard montage, airflow recorded using an oral-nasal thermocouple and either respiratory inductance plethysmography or pneumobelts were employed to record breathing effort. Sleep apnea was defined as >15 apneas + hypopneas per hour of sleep. Central sleep apnea was defined by >5 central apneas/h of sleep. Participants also performed tests of ventilatory responsiveness to hypercapnia during wakefulness using a standard technique.

Hypercapnic ventilatory responsiveness was defined as the slope of the relationship between end-tidal carbon dioxide ($P_{et}CO_2$) and ventilation (l/min). The analyses explored the difference in hypercapnic responsiveness in those CHF patients with and without an apnea + hypopnea frequency (apnea + hypopnea index, AHI) >15/h of sleep. The relationship between hypercapnic ventilatory responsiveness and frequency of sleep-disordered breathing events was also examined.

Results

Ten patients were deemed not to have sleep apnea (AHI <15; range 0–6.8) with the other ten patients having sleep apnea (range of overall AHI: 19.5–107.2; range of obstructive AHI: 0–0.8; range of central AHI: 6.1–79.1). Those with and without sleep apnea were generally well matched; the left ventricular ejection

☆ Javaheri S. A mechanism of central sleep apnea in patients with heart failure. N Engl J Med 1999;341:949–954.

PII: S1389-9457(00)00003-4

fraction was not significantly different (21 ± 6 and 25 ± 7% for sleep apnea and non-sleep apnea, respectively). Pulmonary function was equivalent except for a lower FEV_1, as percent predicted in the group without sleep apnea. The arterial carbon dioxide tension (P_aCO_2) during wakefulness was comparable in both groups (37 ± 2.9 vs. 38.5 ± 2.4, with sleep apnea and without sleep apnea, respectively – mean ± SD, $P = 0.2$).

Patients with sleep apnea slept substantially worse and had greater oxyhemoglobin desaturation than those without sleep apnea (arousal index: 36 ± 22 vs. 14 ± 9 arousals/h of sleep; time with saturation <90%: 64 ± 47 vs. 0.4 ± 1.2 min; nadir of saturation: 76 ± 13 vs. 92 ± 2%, patients with and without sleep apnea, respectively).

CHF patients with sleep apnea had significantly greater hypercapnic ventilatory responsiveness (5.1 ± 3.1 l/min per mmHg CO_2) than those without sleep apnea (2.1 ± 1 l/min per mmHg CO_2) ($P = 0.007$). A significant difference remained even after adjusting for multiple factors including body surface area, vital capacity, maximum voluntary ventilation, oxygen consumption and carbon dioxide production. In addition, the degree of hypercapnic ventilatory responsiveness was significantly correlated with the AHI ($r = 0.6$ with P values 0.01–0.008, depending on the adjustment described above).

Conclusion

The author concluded that hypercapnic ventilatory responsiveness is a major determinant, although not likely to be the only determinant of central sleep apnea in patients with CHF. Whether or not patients with CHF develop central sleep apnea as a result of a genetic predisposition to increased hypercapnic responsiveness, or if the increased responsiveness is acquired is not known.

Comment

As Dr Javaheri clearly demonstrates, CHF patients with sleep apnea experience substantial disturbances of sleep and breathing. Left untreated, it is likely that these abnormalities will contribute to an accelerating downhill course. Additionally, in view of the notable sleep disturbances, sleep medicine practitioners may be asked to participate in the care of these patients. It therefore behooves us to understand the pathogenesis because it may improve management approaches. It is evident that augmented hypercapnic ventilatory drive in CHF patients with central sleep apnea makes it very different from other patients with 'central hypoventilation' who are often thought to have decreased ventilatory 'drive'. As discussed in an editorial by Neil Cherniack, which accompanied this article, hypoxia may increase the 'gain' of the control system and increase the likelihood of periodic breathing. It is recognized that administration of supplemental oxygen reduced the number of central sleep apneas in CHF and it is possible that it does so by decreasing the 'gain'. The relative therapeutic roles of supplemental oxygen and positive pressure therapy in the care of these patients is the subject of on-going and planned investigations.

In contrast to previous studies, Javaheri did not observe that the patients with sleep apnea had augmented ventilation or lower arterial carbon dioxide tension (P_aCO_2) during wakefulness relative to the non-sleep apnea patients. It had been suggested that such hyperventilation be a clinical clue to the possibility of periodic breathing during sleep. Although low normal, the similarity of awake P_aCO_2 in the two patient groups reported by Javaheri's data diminishes the likelihood that this variable will be a useful clinical tool although it may be an adjunct to a good medical and sleep history and physical examination.

Finally, this study may be criticized for not employing an esophageal catheter to definitively distinguish central and obstructive events. This is a valid criticism and the deficiencies of the author's methodology should be noted in interpreting the results. However, in the opinion of this commentator, although it is probable that some events were misclassified, I believe that a population of CHF patients with an elevated central apnea frequency was identified and the results stand on their own merit.