

Advances in Positive Airway Pressure Treatment Modalities for Hypoventilation Syndromes



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KEYWORDS

- Hypoventilation syndrome • Obesity • Sleep • Obstructive sleep apnea
- Continuous positive airway pressure • Positive airway pressure • Artificial respiration • Algorithms

KEY POINTS

- The physiologic rationale for advanced positive airway pressure (PAP) modalities is sound considering the complexity of sleep-disordered breathing in patients with hypoventilation syndromes.
- The therapeutic physiological rationale for the various advanced PAP modalities and the details about the principles of operation and technology implementation need to be well-understood by the prescribing health care provider.
- Sleep-disordered breathing is complex and requires sophisticated devices with algorithms designed to accurately detect and effectively treat respiratory events that include hypoventilation, upper airway obstruction, lower airway obstruction, central apneas, and central hypopneas, and reduce the work of breathing while maintaining breathing comfort.
- There is much opportunity for further refinement of these devices that include the ability of the device to reliably monitor gas exchange, sleep-wakefulness state, and for reducing variability in device efficacy owing to provider-selected device settings.

INTRODUCTION

Positive airway pressure (PAP) therapy for hypoventilation syndromes can significantly improve health-related quality of life (HR-QOL), health care costs, and even mortality.^{1–3} Such important, patient-centered and health care-related outcomes are affected by the beneficial effects of PAP therapy on intermediary physiologic endpoints such as improved gas exchange and better

sleep quality accomplished during both sleep and wakefulness.^{1,4,5} Although different definitions for advanced PAP therapy may exist, for the purposes of this review, advanced PAP modalities refer to modes other than continuous PAP (CPAP) therapy administered by noninvasive mask interface during sleep. They could be broadly categorized into bilevel PAP, automated PAP therapy, volume-targeted pressure assistance (volume assured pressure support), volume control invasive or

Disclosures: See last page of article.

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noninvasive ventilation, or new and emerging devices that administer ventilatory assistance during wakefulness in ambulatory patients. The therapeutic physiological rationale for the various technological options and details about the technology implementation are provided herein. Supporting randomized, clinical trials and other clinical evidence are discussed elsewhere in this issue by Murphy and Hart.

THERAPEUTIC OPTIONS AND PHYSIOLOGIC RATIONALE

The need for advanced PAP modalities should ideally be viewed in the context of the entire gamut of therapeutic options and their respective targets in patients with hypoventilation syndromes (Fig. 1). Although conventional CPAP arguably could be effective in most cases of obesity hypoventilation syndrome, there are instances when CPAP may fail to adequately correct sleep-related hypoventilation.^{6,7} Specifically, Piper and colleagues⁷ performed a head-to-head study comparing CPAP with bilevel PAP therapy and came to the conclusion that both treatments were equally effective in improving daytime hypercapnia in a subgroup of patients with obesity hypoventilation syndrome without severe nocturnal hypoxemia. The seclusion of patients with severe nocturnal hypoxemia identifies the subgroup of patients who need a more advanced form of ventilation. In keeping with such

an observation, Banerjee and colleagues⁶ noted that patients with obesity hypoventilation with 4 characteristics that includes severe hypoxemia during sleep—namely, greater levels of morbid obesity, restrictive defect on pulmonary function testing, and greater levels of daytime hypercapnia—are also more likely to fail CPAP therapy. Failure of CPAP therapy may also be attributable to the fact that CPAP therapy may not measure and therefore effectively abrogate other pathophysiologic derangements that underlie the various hypoventilation syndromes (Fig. 2). In the case of obesity hypoventilation syndrome, whereas CPAP may have been effective in abrogating the obstructive hypoventilation, the inspiratory assistance required to surmount the chest wall load owing to morbid obesity may have been insufficient (see Fig. 2). Such differences in efficacy of various PAP therapy modalities may apply not only to patients with obesity hypoventilation syndrome, but to other causes of hypoventilation syndromes as well (see Fig. 2).

Morbid obesity may be associated with expiratory airflow limitation.^{8–10} Such expiratory flow limitation can contribute to gas exchange abnormalities that could benefit from the application of positive end-expiratory pressure (PEEP).¹⁰ Such expiratory flow limitation in morbidly obese individuals may be secondary to mechanical compression of the smaller airways. However, different levels of PEEP may be required to provide ventilatory assistance versus adequately treat upper

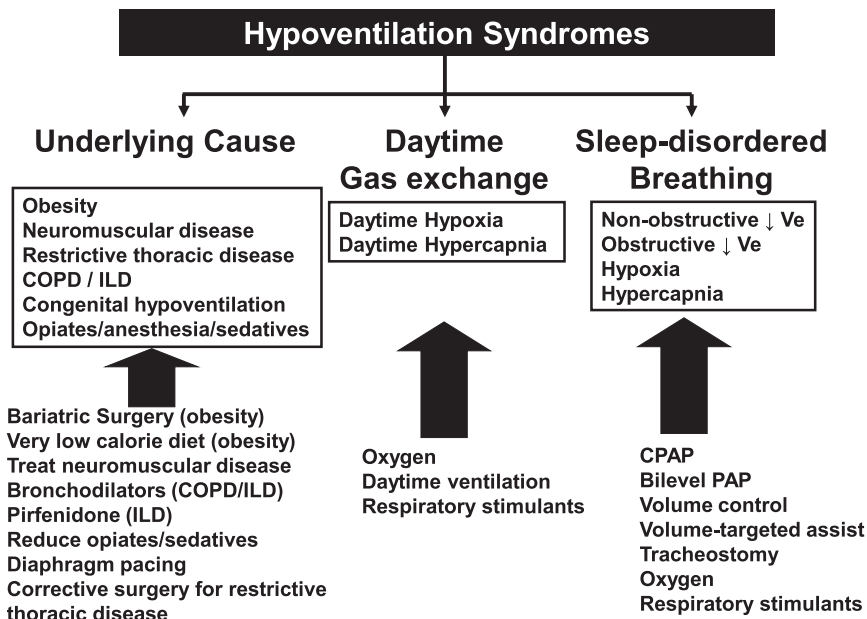


Fig. 1. Underlying pathophysiologic characteristics of hypoventilation syndromes and various therapeutic interventions that could be used to provide targeted treatment. Positive airway pressure therapy is one of many available treatment modalities.

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