Modes that can reduce dyssynchronies

Proportional Assist Ventilation (PAV)

Is a continuous spontaneous mode that adjusts pressure support in proportion to patient effort. [1] The ventilator calculates the system compliance (C) and resistance (R) and estimates the patients' inspiratory effort (Pmus) through integration of the equation of motion: $Paw + Pmus$ = (flow×R) + (volume/C). knowing the airway pressure (Paw) delivered and calculating the right side of the equation, the ventilator can solve for the patient's Pmus. [2] PAV translates the Pmus into work of breathing (WOB) according to the equation: $WOB_{PT} = \int Pmus^{dV}$. [3] This allows the clinicians to set the amount of support from the ventilator according to patients' effort.

Theoretically, PAV should reduce dyssynchronies related to work shifting. However, the triggering criteria (flow or pressure) remains as other traditional modes and makes it vulnerable to trigger dyssynchronies like (missed, delayed, early triggers) especially if over assistance, diaphragmatic weakness or presence of auto-PEEP. Additionally, the cycling criteria is also similar to conventional pressure support mode (PSV) where the ventilator cycles when the flow decays to a certain level (3L/min by default) makes it vulnerable to cycling dyssynchronies (early or late cycle). [4] Studies comparing the efficacy of PAV versus PSV in reducing dyssynchronies have shown the PAV reduced dyssynchronous PVI but less able to reduce the inspiratory delay with high levels of auto-PEEP [5,6,7] nevertheless, these physiological advantages have not improved outcomes such as the duration of mechanical ventilation, delirium, or cognitive impairment. [8]

Neurally Adjusted Ventilatory Support (NAVA)

Is a novel mode of ventilation that uses the Electrical diaphragmatic activity (Edi) to trigger the breath, proportionally adjust inspiratory pressure according to the signal strength and set support level (NAVA level) as Pdelivered = (Edi x NAVA Level) + PEEP, and cycles the breath at 70% of the peak Edi. [9] Many studies have evaluated the efficacy of NAVA compared to PSV to reduce PVD during invasive and non-invasive ventilatory support, [10,11,12] NAVA improve patient-ventilator coupling with associated improvement in comfort and dyspnea, appears to achieve consistently less asynchrony index, excessive inspiratory time at the cost of a consistent trend toward a higher incidence of double triggering. [3] Diaphragmatic dysfunction/weakness or other neurological condition that can affect the signal transmission and the neuro muscular coupling are among the disadvantages using this mode.

Adaptive ventilation modes (ASV)

Is an intelligent mode of mechanical ventilation protocol which uses closed-loop control between breaths. The algorithm states that for a given level of alveolar ventilation, there is a particular respiratory rate and tidal volume which achieves a lower work of breathing. The mode allows the clinician to set a desired minute ventilation percentage (MV%) while the ventilator automatically selects the target ventilatory pattern based on these inputs and feedback from the ventilator monitoring system. [13] The ability of the mode to switch between controlled, intermittent, spontaneous modes has the potential to reduce dyssynchronies. The ability to adjust the pressure delivered based on respiratory mechanics theoretically should reduce work shifting. Despite the available evidence of the benefits of ASV in reducing mechanical power [14] and might be superior for weaning, [15] few studies examined ASV in regard to PVI, one study found better synchrony compared to SIMV, [16] another study found that high inspiratory effort resulted in higher tidal volume and minute ventilation though no mention on dyysynchronies. [17] One caveat is the mode uses adaptive pressure control in spontaneously breathing patients to adjust the pressure for a warranted tidal volume, with high inspiratory efforts, the tidal volume will increase, and the ventilator will react by reducing the delivered pressures that might cause further work shifting.

Other methods of estimating diaphragmatic work are available like diaphragmatic ultrasound, [18,19] surface electromyographic (sEMG) measurements, [20] or other non invasive real time (N-Pmus) monitoring method. [21] However, those haven't been studied rigorously or been incorporated in a certain mode.

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