

## ■ Mechanical Ventilation Advanced Pressure Control Modes

**What is the difference between Inverse Ratio Ventilation (IRV) and Airway Pressure Release Ventilation (ARPV), Bilevel and Proportional Assist Ventilation?**

We know that if a patient is hypoxic the best way to treat this is to give the patient oxygen. There comes a point when the patient will require positive pressure ventilation to enhance oxygenation. The initial support added is CPAP, which improves functional residual capacity, and places the patient on a favorable part of the pressure-volume curve (1;2). If this fails to enhance oxygenation (without the patient incurring oxygen toxicity from high FiO<sub>2</sub> levels), then it is necessary to raise the mean airway pressure to force gas in and out of the alveoli. The patient is put on a mode of inspiratory support – volume control, pressure control or pressure support. Most patients can be easily ventilated in this way. But what if we still have trouble with oxygenation?

We know that cyclical opening and closing of injured lung units damages them (particularly if tidal volumes are large (3;4)). We would prefer if the patient could be ventilated at the top of the volume pressure curve, at high lung volumes, without phasic changes. This can be achieved using high frequency oscillation, but adult oscillators are not widely available. For the majority of patients, increasing mean airway pressure without increasing peak pressure means prolonging the inspiratory time in a pressure control mode. The longer the inspiratory time (T<sub>i</sub>), the better the oxygenation benefit.

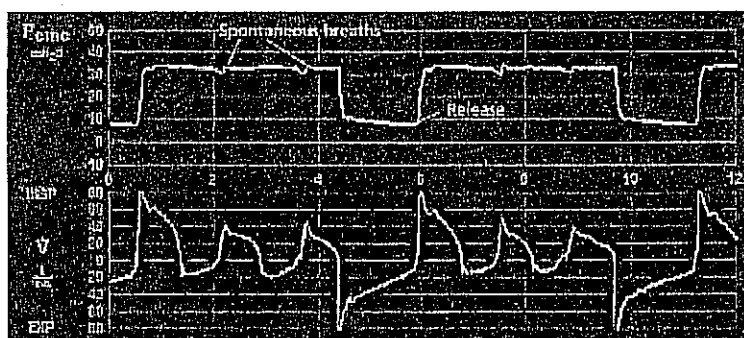
Conversely, once T<sub>i</sub> becomes longer than expiratory time (T<sub>e</sub>), there is insufficient time for CO<sub>2</sub> removal, and this tends to build up. We know the patients tolerate respiratory acidosis very well, and we allow this to happen (permissive hypercapnia). This "inverse ratio" ventilation is very uncomfortable for patients, who generally need to be heavily sedated, often paralysed. In general, we prefer that our patients are awake and interacting with the ventilator – thus newer modes have been developed to enable patients to breath spontaneously on inverse ratio ventilation.

A new method of achieving this uses a modification of ARPV (airway pressure release ventilation) (5). In conventional ventilation, the baseline airway pressure is the PEEP or CPAP level, and ventilator cycling involves application of positive pressure to a higher airway pressure level: the purpose of cycling is CO<sub>2</sub> removal.

The idea of ARPV is that the ventilator cycles between two different levels of CPAP – an upper pressure level and a lower level. The two levels are required to allow gas move in and out of the lung. The key element of ARPV is that the baseline airway pressure is the upper CPAP level, and the pressure is intermittently "released" to a lower level, thus eliminating waste gas.

Bilevel ventilation (bilevel CPAP)(6) or BiPAP (which is often confused with BiPAP, a form of non invasive ventilation), is ARPV with spontaneous breathing. A sophisticated valve has been developed which allows the patient to breath spontaneously at either CPAP/PEEP levels, and partial assistance (pressure support or automatic tube compensation) can be introduced to assist the spontaneous breaths. This mode appears to be extremely well tolerated, and heavy sedation is not required (it is in APRV and IRV).

Any intensive care patient can be managed on this mode of ventilation. Bilevel can be used as conventional pressure controlled ventilation, or as Airway Pressure Release Ventilation. This involves ventilating the patient, essentially, at full tidal volumes. Usually an i:e ratio of 8-9:1 is used (however - the short expiratory time is the key variable). This is generally well tolerated by patients - particularly if there is spontaneous breathing, which improves hemodynamic performance and recruiting juxta-diaphragmatic tissues. For more information see here. For more information about ventilation strategy for APRV read here.



Bilevel Ventilation (inverse ratio) note that the patient is breathing spontaneously at the higher PEEP level without any evidence of dyssynchrony.

Proportional assist ventilation is a new mode in which the ventilator guarantees the percentage of work which it does (7), in the face of changes in respiratory system compliance/elastance and resistance. The pressure delivered varies from breath to breath, due to changes in elastance, resistance and flow demand. Usually this is set to overcome 80% of the work of breathing: for example, the pressure required to overcome this may be 14cmH<sub>2</sub>O. So this mode is interactive, as the ventilator varies its output to maintain its proportion of the workload. A version of this is available in some Drager ventilators, and is called "proportional pressure support".

[CLICK HERE TO LEARN ABOUT VENTILATION STRATEGY FOR ARPV](#)

## References

1. Amato MB, Barbas CS, Medeiros DM, Schettino G, Lorenzi FG, Kairalla RA et al. Beneficial effects of the "open lung approach" with low distending pressures in acute respiratory distress syndrome. A prospective randomized study on mechanical ventilation. *Am J Respir Crit Care Med* 1995; 152(6 Pt 1):1835-1846.
2. Amato MB, Barbas CS, Medeiros DM, Magaldi RB, Schettino GP, Lorenzi-Filho G et al. Effect of a protective-ventilation strategy on mortality in the acute respiratory distress syndrome. *N Engl J Med* 1998; 338(6):347-354.