# APRV FOR THE RETICENT PRACTITIONER: A CLINICAL NOTE

*by David Wheeler RRT, NPS*

Airway Pressure Release Ventilation, (APRV), is a mode of mechanical ventilation intended to allow patients to breathe spontaneously over intermittent and alternating levels of continuous positive airway pressure, (CPAP). APRV might be better appreciated as a mode of mechanical ventilation that employs continuous positive airway pressure, (CPAP), at alternating levels. These alternating levels of CPAP are termed appropriately at the higher level (Phigh), and with an alternating time-cycled release phase to a lower set pressure, (Plow).

APRV is an intermittent ventilatory support mode that creates the potential for a patient's spontaneous breathing at any point during the ventilator cycle. This is one of the strong points for those of us who work with bipedal mammals. APRV is a time triggered, time cycled, pressure limited intermittent mode of mechanical ventilation. If you are keeping score utilizing the Chatburn taxonomy it is "PC – IMV with a set point targeting scheme".

APRV may be thought of as alternating levels of CPAP with or without pressure support. The time settings for both Phigh and Plow are effectively clinician set and intimately related to tidal volume. The potential for spontaneous breathing throughout the entire ventilatory cycle is one of the key components of this interesting yet rather obscure method of ventilating our patients.

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APRV fashions tidal "volume" swings via pressure release; from Phigh to Plow. This swing in pressure gradient creates tidal ventilation in a linear relationship to the collective mechanical properties of the lung. Lung compliance and regional time constants will greatly influence the potential for tidal volume. Tidal ventilation results from the pressure gradient, lung compliance and percentage of the time constant that is met or satisfied. One of the great clinical advantages of APRV may be that pressure swings are potentially timed to satisfy all regional variances in time constant therefore creating a stable inflation pattern in the context of the recruited and recruit-able lung field. Certainly, if I may ramble further, this potential advantage may attenuate the potential or risk of overdistension and volutrauma while recruiting alveolar surface area.

When a patient is being mechanically ventilated via APRV the majority of time is spent in inspiration or Phigh. The expiratory phase tends to be shorter and the time spent at Plow, (Tlow) is only long enough to meet expiratory time constant demands. As stated earlier APRV is essentially a pressure controlled mode of mechanical ventilation and the tidal volume is a construct of airway pressure, native lung compliance and time at pressure above baseline. Consequently, to assure adequate minute ventilation, either the mandatory breath rate or "tidal volume" must be increased. The rate is a result of Thigh and Tlow, whilst the potential for volume lies in establishing a sufficient pressure gradient. The pressure gradient can be generated by increasing the difference between Phigh and Plow.

The clinician establishes both the time and pressure spent in inspiration (Thigh, Phigh) and expiration (Tlow and Plow). The patient will be ventilated with alternating CPAP levels and in those time intervals whilst always having the potential to breathe spontaneously.

The cogent clinician will realize that both the timing and duration of the pressure release (Plow) will affect ventilation. Again, the delivered VT is dependent on lung compliance, airway resistance, and the duration and timing of the pressure release maneuver. The ventilator cycle is the combination of the inspiratory phase (Thigh) and the expiratory phase (Tlow). The patient's spontaneous breathing efforts remain independent of the mechanical ventilatory cycle and can occur any time the patient wishes to take a spontaneous breath.

Theoretically, extending the time spent at Phigh creates the potential for alveolar recruitment and improved oxygenation. The intermittent release phase to Plow allows for tidal swings and ventilation. The time spent at Phigh may be adjusted to promote spontaneous breathing at Phigh and a potential for increased lung recruitment. Utilizing Thigh, the learned clinician may accomplish lung recruitment without increasing the applied airway pressure. One ought to remain mindful that the release time must be greater than three time constants to avoid the potential for excessive intrinsic PEEP. Therefore, time spent at Plow should be titrated to satisfy native time constants and permit complete exhalation to resting lung volume.

It is important to note that the set Phigh is not the highest pressure created at the alveolar level, be reminded that spontaneous breathing during Phigh generates negative pleural pressures that add to the potential for alveolar stretch. The potential for alveolar stretch will be determined by the volume potential at a given pressure. The compliance of the regional lung units will determine the potential for stretch due to excessive volume generation. Remember it is volume not



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pressure that is responsible for overdistention, VILI and VALI. The informed clinician will assess the potential for excessive shear forces, RACE, volutrauma and atelectrauma when the ventilator is cycling between Phigh and Plow. The assessment of the mechanically ventilated patient is one of the most fundamental duties in our scope of practice and must be both intelligently and compassionately performed.

The tactile ventilator settings of APRV include two pressure levels: Phigh and Plow; as well as two time intervals: Thigh and Tlow. The gradient between these two pressures will determine the potential for tidal volume swings. It is recommended that some level of pressure support or automatic tube compensation be added to assist spontaneous breaths. The time difference in Tlow generates potential for tidal movement when considered in the context of the patient's global expiratory time constants and in relationship to Thigh. The I:E of APRV $\approx$ 4:1. The clinician must use discretion in fashioning the I:E. Native pulmonary mechanics should guide I:E selection.

The spontaneous breathing intrinsic to APRV will create diaphragmatic contractions that may enhance the recruitment of atelectatic alveoli in dependent regions of the lung field. This spontaneous breathing aspect has the theoretical potential to expand ventilation-perfusion matching as well as decrease intrapulmonary shunt. The spontaneously breathing patient will also demonstrate a reduced sedation and analgesia requirement.

Indeed, it has been noted elsewhere that conventional mechanical ventilation typically leads to poor ventilation of dependent lung regions. This is due to the weight of the lungs and intra-abdominal contents; the perfunctory shift of the diaphragm, absence of diaphragmatic contraction in fully ventilated patients and "gravitational" influences on the distribution of ventilation. However, when we allow for spontaneous breathing there is a corresponding enhanced ventilation of dependent areas. This augmented ventilation to dependant regions may cause improved ventilation–perfusion matching, decreased atelectasis and improved ventilation perfusion relationships. Additionally, the decrease in intrathoracic pressures during spontaneous breathing enhances venous return and biventricular filling. This may improve cardiac output and the potential for oxygen delivery.

Recent investigations comparing APRV and conventional ventilation demonstrated a few interesting clinical outcomes. In the APRV group the durations of ventilatory support, intubation and of ICU stay were decreased. This may lead to further investigation especially in the areas of Acute lung injury, postoperative weaning, and the mechanical ventilation of the acute cardiovascular patient.

The potential and somewhat theoretical benefits of APRV include the augmentation and continuation of alveolar recruitment, improvement of oxygenation, reduced potential for overinflation. Perhaps the greatest aspect of APRV is in the preservation of spontaneous breathing which has several hemodynamic and pulmonary advantages. This continues potential for spontaneous breathing cannot be overstated. In the greater context of the patient-ventilator system the spontaneous breath has enormous clinical bearing both as an assessment numeric and therapeutic bench-mark.

APRV is a mode of ventilation that is worth exploring as an adjunct to your therapeutic arsenal. This note is but a brief and cursorily introduction to this relatively intricate subject and I would urge the intellectually curios to further reading.

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