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## Clinical Practice

# "Airway Pressure Release Ventilation" a step up care in ARDS

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**Abstract:**

*APRV is a mode of mechanical ventilator which uses the principal of open lung approach. It is thought to be an effective & safe alternative for difficult to oxygenate patients like ARDS. It is inverse ratio, pressure controlled, intermittent mandatory ventilation with unrestricted spontaneous breathing. APRV has many purported advantages over conventional ventilation including alveolar recruitment, improved oxygenation, preservation of spontaneous breathing, improved hemodynamics and potential lung-protective effects. It has many claimed disadvantages related to risks of volumtrauma and increased energy expenditure related to spontaneous breathing. Though it was first described more than 20 years ago still it has not gained popularity till date as it is yet to prove its mortality benefits over other conventional modes. Currently there is a lot of ongoing trial globally on it.*

***Key Words:*** *APRV, ARDS, Ventilator Mode.*

### Introduction:

The primary goal of this mode is to combat hypoxia but it is thought that it is a better mode in terms of alveolar recruitment, improved oxygenation, preservation of spontaneous breathing, improved haemodynamics & potential lung protective effect. This mode uses different terminology & approach. In APRV alveolus remain distended in most of the time in respiratory cycle with small intermittent release. In this mode patient breaths spontaneously in any part of the respiratory cycle & thus can maintain the physiology of normal breath. It causes physiological movement of the diaphragm & change of pleural pressure causing less V/Q mismatch. Generally it needs less sedation & is free from the adverse effects of them.

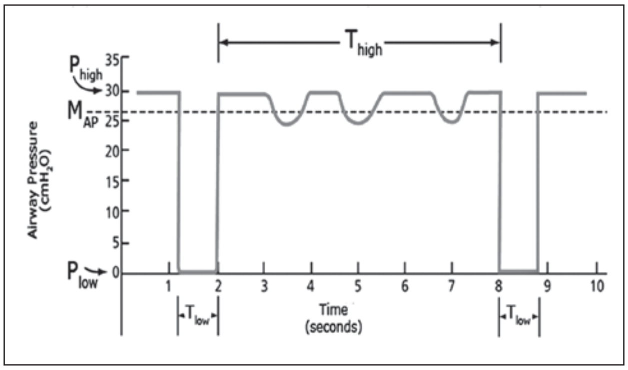


***Figure 1:*** *This is a pressure-time graph of typical airway pressure release ventilation (APRV) mode.*

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### What is APRV:

APRV is actually a CPAP mode with intermittent release phase. It applies CPAP (P high) for a prolonged time (T high) to maintain adequate lung volume and alveolar recruitment. It has a time-cycled release phase to a lower set of pressure (P low) for a short period of time (T low) or (release time) where most of ventilation and $CO_2$ removal occurs. In acute respiratory distress syndrome (ARDS), the functional residual capacity (FRC) and lung compliance are reduced. The combination of those causes elevation of the elastic work of breathing (WOB). By applying CPAP, the FRC is restored and inspiration starts from a more favorable pressure-volume relationship, facilitating spontaneous ventilation, and improves oxygenation.[1] Applying 'P high' for a 'T high' (80–95%) of the cycle time, the mean airway pressure is increased insuring almost constant lung recruitment (open-lung approach). In contrast to the other conventional ventilatory methods APRV dose not cause repetitive inflation and deflation of the lung, which could result in ventilator-induced lung injury (VILI);[2,3]. Spontaneous breathing plays a very important role in APRV, allowing the patient to control his/ her respiratory frequency without being confined to an arbitrary preset inspiratory:expiratory ratio (I:E). Thus improving patient comfort and patient-ventilator synchrony with reduction of the amount of sedation necessity. Additionally, spontaneous breathing helps to drive the inspired gas to the nondependent lung regions by using the patient's own respiratory muscles and through pleural pressure changes producing more physiological gas distribution to the nondependent lung regions and improving ventilation/ perfusion (V/ Q) matching.[4–7]

### When to use APRV:

**Indication:**

- Primarily used as an alternative ventilation technique in patients with ARDS.
- Used to help protect against ventilator induced lung injury.

**Possible Contraindications**

- Unmanaged increases in intracranial pressure.
- Large bronchopleural fistulas

- Possibly obstructive lung disease.
- Technically, it may be possible to ventilate nearly any disorder.

**Terminology:**

P High – the upper CPAP level. Analogous to MAP (mean airway pressure) and thus affects oxygenation

P Low - is the lower pressure setting.

T High- is the inspiratory time IT(s) phase for the high CPAP level (P High).

T low- is the release time allowing CO2 elimination

**APRV setting:**

As in any ventilation strategy in ARDS, the goal should be to ventilate the lung on the steep portion of the pressure-volume curve. Where the tidal volume should be between the upper & lower inflection point[12] [Fig 2] which has proven to reduce the ventilator induced lung injury [VILI] [9-11].

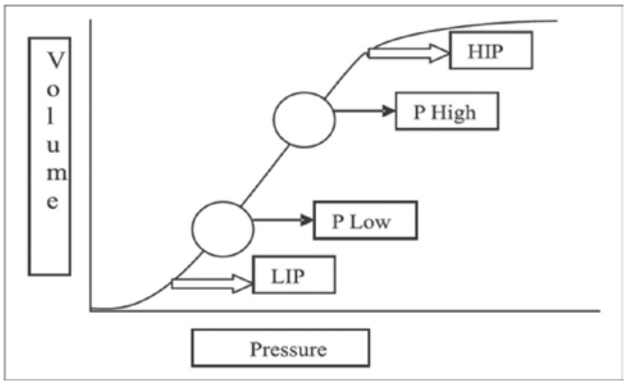


***Figure 2:*** *Static pressure-volume curve during volume-controlled mechanical ventilation. High pressure ('P high') is set below the high inflection point (HIP) and low pressure is set above the low inflection point (LIP)* [14].

In case of APRV setting there are two excepted methods of practice till date. In one method there is short T low with a P low of zero cm $H_2O$ with prolonged I: E ratio. This causes air trapping creating auto PEEP. This deliberate auto PEEP prevents lung collapse causing constant alveolar recruitment. In another method there is longer T low to eliminate auto PEEP with higher P low (generally above the lower inflection point) to avoid alveolar collapse. There are a very few data to support any of the two methods[12, 13]. But the fore mentioned method is better to most of the author, as it does not need to analyze the pressure volume curve & in many times it may be difficult to get a clear curve. The following method may be followed easily.

**Initial Settings – P High**

- P High – Set a plateau pressure (adult)
- Typically about 20-25 cm $H_2O$.
- In patients with plateau at or above 30 cm $H_2O$, set at 30 cm $H_2O$
- Over-distention of the lung must be avoided. Maximum P high of 35 cm $H_2O$. (controversial)
- Exceptions for higher settings – morbid obesity, decreased thoracic or abdominal compliance (ascites).

**Setting Thigh/T low**

- The inspiratory time (T high) is set at a minimum of about 4.0 seconds.
- Usually the T high should be 80-95% of the respiratory cycle.
- The more the T high ratio, the more favorable for oxygenation.
- Progress slowly for example start with T high: T low = 4.2 sec: 0.8 sec and then change as ABG.
- Target is oxygenation.

**P low**

- With short T low it is generally 0 cm of $H_2O$.

**Troubleshooting:**

Making Changes in APRV Settings Based on ABGs. The basic changes may be done by the following ways.

**$CO_2$ Elimination (To Decrease $PaCO_2$):**

- Decrease T High.
  - Shorter T High means more release/min.
  - No shorter than 3 seconds
  - Example: if initial T High: T Low is 4.2: 0.8 sec it may be changed to 4: 1 sec.
- Increase P High to increase volume exchange. (2-3 cm $H_2O$/change)
  - Monitor tidal volume.
  - PIP (best below 30 cm $H_2O$)
- Check T low. If possible increase T low to allow more time for "exhalation."

**To Increase $PaCO_2$**

- Increase T high. (fewer releases/min)
- Slowly! In increments of 0.5 to 2.0 sec.
- Decrease P High.
  - Monitor oxygenation and
  - Avoid derecruitment.
- It may be better to accept hypercapnia than to reduce P high so much that oxygenation decreases.

**Management of $PaO_2$**

**To Increase $PaO_2$**

1. Increase $FIO_2$
2. Increase MAP by increasing P High in 2 cm $H_2O$ increments.
3. Increase T high slowly (0.5 sec/change)
4. Recruitment Maneuvers
5. Maybe shorten T low to increase T High in 0.1 sec. increments (This may reduce VT and affect $PaCO_2$)

## Weaning From APRV

Some authors[15, 16] have described a "drop and stretch method" of weaning APRV; they gradually reduced the level of P high ("drop") and reduced the number of releases by increasing the T high ("stretch") until the mode is converted to CPAP as a method of spontaneous breathing trial before extubation.

1. $FiO_2$ should be weaned first. (Target < 50% with $SpO_2$ appropriate.)
2. Reducing P High, by 2 cm $H_20$ increments until the P High is below 20 cm $H_2O$.
3. Increasing T High to change vent set rate by 5 releases/minute
4. The patient essentially transitions to CPAP with very few releases.
5. Patients should be increasing their spontaneous rate to compensate.

A study by Rathgeber and colleagues[17] compared duration of weaning between BIPAP, VC-IMV, and volume controlled continuous mandatory ventilation (VC-CMV) in postoperative cardiac patients, and reported a small yet significant reduction in time on mechanical ventilation. So the weaning may be done by using other mode also where we can use the conventional methods of weaning like pressure support ventilation (PSV) or T-tube.

During Weaning

Add Pressure Support judiciously.

Add Pressure Support to P High in order to decrease WOB while avoiding over-distention,

P High + PS $\leq$ 30 cm $H_2O$.

## Conclusion:

Airway pressure release ventilation is a simple, safe and effective ventilatory method for patients with ARDS. Currently there is some but no strong evidence to suggest its superiority above other conventional ventilatory methods in regard to oxygenation, hemodynamics, regional blood flow, patient comfort and length of mechanical ventilation. There is no evidence of improved mortality outcome by using APRV as compared to other modes of mechanical ventilation. There is a need for large human trials to compare APRV to conventional mechanical ventilation using lung-protective strategies before drawing final conclusions about this interesting mode of ventilation. Currently APRV is not recommend for every patient with ARDS; but for carefully selected patients, consultation with specialist and respiratory therapist with expertise in using APRV may be necessary.

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